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A Question of Priority.

A NOTE from Prof. W. A. Anthony calls our attention to the fact that the alternating current motor devised by Mr. Van Depoele, and described in our issue of Aug. 16, is very closely similar to a motor patented two years ago by Professor Anthony in company with two coadjutors. An examination of the patent in question shows indeed a striking resemblance in the general construction employed. It seems to be one of those instances where two inventors, working to accomplish the same end, have selected means remarkably alike. The same thing has often happened before in the course of electrical invention, and is likely often to occur again. The number of really dissimilar forms of dynamo-electric machines is comparatively limited, and almost any machine of to-day will be found to have a more or less closely similar prototype dating back anywhere from one to fifty years. We feel it our duty, however, to call attention to this note from Professor Anthony, as he seems to be entitled to credit in the matter.

Two Interesting Papers.

WE give this week a brief account of the electrical papers read at the Indianapolis meeting of the American Association for the Advancement of Science. Perhaps the most interesting to scientific electricians was the paper by Messrs. Morley and Eddy on "The Velocity of Light in a Magnetic Field." The results were indecisive; but there is promise of more definite experiments under better conditions. The subject is specially worth attention in view of the very numerous ways in which the phenomena of light and electricity are now approaching a common basis. Another paper worth thinking of was Mr. Rosa's "Study of the Specific Inductive Capacity of Electrolytes." The experimental investigation of the subject is not particularly easy, and the results reached leave the matter still somewhat in doubt. It does not seem probable, judging from what we know of the properties of light and of electricity, that a difference in period between the forces at work in the propagation of light and the electrical stresses measured is sufficient to account for the observed results. Differences in phenomena due to this cause have been sought before in the study of the electro-magnetic relations of light, but with negative results; and we rather hesitate in accepting so convenient but dubious an explanation for the differences found in the experiments.

A Curious Study in Magnetism.

WE print in full on another page a very instructive study of the magnetic properties of iron-nickel alloys, by Dr. John Hopkinson. The facts disclosed add new complications to the extraordinary anomalies presented by that curious trio of metals, iron, nickel and cobalt. Perhaps the most striking peculiarity noticed was the varying effects of different proportions of nickel. A nickel steel containing a little less than five per cent. of the former constituent is decidedly more magnetizable than wrought iron, particularly for high inductions. On the contrary, with 24.5 per cent. of nickel the alloy is non-magnetic at ordinary temperatures, but after being exposed to a very low temperature it becomes slightly magnetic, and remains so up to more than 500 degrees C. With 73 per cent. of nickel, however, an alloy is obtained that is much more magnetic than the preceding or than a mechanical mixture of iron and nickel in the same proportions. In the specimen of nickel steel first mentioned there were two well marked "critical points" at temperatures about a hundred and fifty degrees apart, and all magnetic properties vanished on heating to the higher point to reappear, on cooling, only at the lower one. All these facts point to some eccentric sort of chemical combination. The non-magnetic alloy contained very nearly three molecules of iron to one of nickel, but the cause of the phenomena observed is by no means as simple as this might indicate, since a small proportion of nickel increases the magnetic properties of the material. It is strange that so much mystery should surround the physical character of the commonest of the metals, but there is much to indicate that we may some day have to revise our definition of iron and look more closely into its chemical nature.

A Standard of Light.

THE brief account of the Siemens-Violle standard lamp presented this week raises some very pertinent questions. The arrangement, as illustrated, is a very ingenious one, and it is so simple and easy of manipulation that it would appear at first sight to be a not impracticable standard; but on examining Dr. Liebenthal's account of the experiments and the results obtained we meet little but disappointment. In the first place, the method of experiment is highly unsatisfactory, because since the platinum strip reaches its standard intensity of illumination for but a moment before melting the photometer disc cannot be moved to and fro according to the method which experience has shown to be necessary for accuracy, but virtually a single reading must be taken. As is well known to any one who has worked much with the Bunsen photometer, there is a sort of neutral zone of considerable extent, especially when the lights compared are of different colors, and any method that depends on a single setting or the maximum reading of the disc, when being moved in one direction, is necessarily inaccurate. The results obtained with this new form of standard are such as might be expected under the circumstances, the mean error in 100 readings being three times as great as the mean error in comparing two amyl-acetate lamps. When we consider the experimental errors introduced by the momentary character of the standard illumination, the variations known to occur in the platinum light itself, and the difference in color between this and most other forms of light, it becomes only too evident that the standard suggested by the Paris Congress is for practical purposes about as inconvenient and inexact as could be found. As an evidence of this we need only instance that two very elaborate comparisons of the standard candle with the incandescent platinum, made by two entirely independent observers, differ from each other by more than 20 per cent. Comparisons with the amyl-acetate lamp give results nearly as discordant. The whole question of the proper unit of light has proved to be a very puzzling one, and the results reached by the Paris Congress have been anything but satisfactory. We hope that at the next International Congress of Electricians steps will be taken to devise a unit of a more practical, not to say possible, character.

Popular Rapid Transit.

A WELL KNOWN daily paper recently made an endeavor to find out the general pubic opinion of the electric railway system. To this end it sent out to the mayors of a large number of cities a brief series of questions relating to the employment of electrical power. These questions were five in number, and were substantially as follows: What system of electric cars is in use in your city? Have any persons been seriously injured, or killed? Is any apprehension felt among your people as to safety on account of this electric system? Has the street car service been improved as a result of its introduction? Is popular feeling in favor of the overhead wire or hostile to it? Twenty-seven replies were soon received to this series of inquiries, and the study of them is most suggestive. Without a single exception every letter showed outspoken approval of the electric traction system now in use. No case of death or even serious injury to a human being was reported, although in several places it was stated that horses had been killed. In Nashville three horses died from shocks received from telephone wires falling across the trolley wire, and a negro woman who accidently seized one of these same fallen wires was knocked down, but received no injury. With one accord all the officials announce great improvement in the street car service and frequently great rise in value of real estate along the lines as the result of improved rapid transit facilities. With reference to the last question asked, public opinion seemed to be uniform in favor of the present system, although in certain places the use of overhead wires is disliked. Very little apprehension seems to have been felt on account of the bare trolley wire, and this little appeared to be rapidly disappearing as the system became more familiar. In all this there is a most unqualified endorsement of electric street railways by a body of men who from their official position have the best possible opportunities of learning the state of public feeling on the subject. There is considerable reason to believe that nearly all the agitation against overhead wires has been the result of business rivalry and not of public apprehension. The electric road has come to stay and eventually to drive out all other systems of propulsion. A very short time suffices to convince a community that electric rapid transit is of inestimable value in facilitating business, in developing outlying districts and saving valuable time for immense numbers of people. There has not yet been recorded during the five years that electric street cars have been in operation a single case of fatal shock to a human being; and, in spite of all that is being said by hysterical grumblers to the contrary, this fact remains an incontrovertible answer to every accusation of danger that is made against electric traction.

An Insular Protest.

THE recent publication in our columns of a description of Prof. Elihu Thomson's new alternator seems to have perturbed the spirits of some of our English friends most seriously. It has been referred to in rather sweeping terms as being closely similar to one of the forms of dynamo proposed by that very clever electrician, Mr. Mordey, some three years since. The English machine referred to is of very simple character, and we think that a brief description will make it evident that it bears a very slight resemblance to Professor Thomson's later design. It consists of a group of horse-shoe electromagnets, arranged in a circle, and with poles pointing radially inward. On the poles are wound armature coils, and about the yokes of the magnets are wound the magnetizing coils. A series of laminated keepers revolving in front of these poles vary the induction. Now, we would submit that a machine of this character is distinct in every way from that recently patented by Prof. Thomson. This latter machine has no radiating keepers whatever, but does revolve a group of consequent north poles pointing radially outward from the axis in front of a group of south poles pointing inward. On these latter are wound the armature coils, while both sets of poles are magnetized by field coils wound on bobbins around the axis of rotation that forms a part of the magnetic circuit. If there is any resemblance between the two machines just described, either in principle or in details of construction, we fail to see it. So far as we are aware, the arrangement of the magnetic circuit of the Thomson machine is decidedly novel, and although, as one of the English critics remarked, it may be objected to on theoretical grounds, it must be remembered that the Thomson-Houston arc dynamo which to-day occupies a very prominent place in the electric lighting of the world, has a magnetic circuit to which many exceptions may be taken. The example of the Mordey machine picked out by our English contemporaries, was specially unfortunate, for it is far less like the Thomson machine than several other forms that we could mention; and in the next place it was proposed and constructed very nearly 20 years before Mr. Mordey entered upon the scene of his earthly activity. The principle was plainly laid down both by Ritchie and Page prior to 1840, and there is something peculiarly amusing in the defence of Mr. Mordey's alleged priority of ideas as against the "American novelty." Even the principle of magnetizing several poles by a single coil, utilized in most forms of Mr. Mordey's machines, is more than 20 years old. A dynamo with fixed armature and rotating keepers is one of the oldest known types. In the Thomson machine, however, there are no rotating keepers whatever, but a rotating group of poles instead, and by reason of its mechanical simplicity, freedom from moving wire or moving contacts of any kind, and ease of construction, it is decidedly a promising machine. Furthermore, in this general principle of rotating a group of poles of similar polarity before another group of opposite polarity, the whole being magnetized by a single set of coils, it bears no resemblance to the particular machines to which our English friends have referred. It is a very difficult matter in the present state of the art to design a machine which cannot be accused by somebody of being remarkably similar to some previously known form; but it would be difficult to find a dynamo of any promise in practical performance of which this could be said with less truth than of the machine in question.

NEW BOOKS.

PRACTICAL DYNAMO BUILDING FOR AMATEURS. By Frederick Walker. 104 pp., 20 illustrations. New York: D. Van Nostrand, 1890. 50 cents.

This little book has already run through two English editions, and the present first American edition has been carefully revised. Like several others now before the public, it is designed to give the intelligent amateur, who is somewhat skilled in machine work, working designs and directions for dynamo building; and although it must appeal to a comparatively limited class, it seems very well adapted for the purpose. The patterns described have been actually made and tested, and the practical details of building machines are pretty thoroughly worked up. It is a pity that a little more scientific method has not been followed in the design, for it ought to be quite as easy to give amateurs the general theory of winding small machines as to give them minute directions for the work. It would have been better, too, had the wire tables been reduced to the Brown & Sharpe gauge almost exclusively used in this country, instead of remaining in the new British wire gauge. The difference is enough to mislead unless the fact is clearly borne in mind. The usual difficulty in machines built by amateurs is that sufficient care is not taken in making the magnets. It must be remembered that if a magnet is to be made of cast iron, only the very best quality should be used and the complete castings should be most thoroughly annealed, otherwise the electromotive force developed on given specifications will be disappointingly small and the machine will be somewhat inefficient, even if the windings are changed to give the required intensity of magnetization. The directions given throughout are clear and explicit, and it is hard to see how a machine built in accordance with them can fail to give satisfactory results, if care is taken with materials used. It may be well to know that these patterns would answer admirably for motors with a slight change in the position of the brushes. It would really be very desirable if a book similar in character to this could be written which should put the designing of small machines on a scientific rather than an empirical basis. Such a work would not be at all more difficult to understand or to work from and it would add very considerably to the electrical knowledge of the amateur who should follow its instructions.

Electrical Papers at the Annual Meeting of the American Association for the Advancement of Science.

BY PROF. A. P. CARMAN.

The American Association for the Advancement of Science met in Indianapolis Aug. 20. The physical section was presided over by Professor Cleveland Abbe, of Washington, D. C. Of the large number of papers read, I notice the following, which will be found to be of more or less interest to electricians.

(1) "Note on Certain Peculiarities in the Behavior of a Galvanometer when used with a Thermopile," read by Ernest Merritt, of Ithaca, N. Y. The peculiarities observed occur under the following circumstances: The thermopile, one face of which is kept at a constant temperature, is connected permanently with a suitable galvanometer. On suddenly exposing the other face to some source of heat by removing a screen the galvanometer needle starts quickly to one side, but in the course of a few seconds moves more slowly, stops, and even moves backward a short distance. This behavior is then repeated and the final steady deflection is reached only after a long series of such small throws, which gradually become less noticeable as the deflection increases.

It has been observed (1) that the interval of time between two consecutive maxima and minima is a constant, and equal to the period of free vibration of the needle; (2) that the first throw of the needle under the circumstances above described always bears a constant ratio to the final deflection, no matter how the source of heat may be varied. In one case this first swing had a proportion of .32 to the final deflection. It follows from the last fact that it is not necessary to wait for the final deflection in comparative work with the thermopile. Errors introduced by slight changes in the zero point may thus be more readily avoided.

The phenomena are found to be completely explained if the assumption is made that the heating of the exposed face of the pile takes place in accordance with Newton's law of cooling. It is possible to express this with more or less exactness by the use of mathematical formulæ. The curve gotten by combining that for cooling with that of the decrement of the galvanometer was found to be the same as that gotten by observing the phenomena. The abscissas are used to represent time and the ordinates deflection in these curves.

(2) "Method of Measuring the Electrical Resistance of Liquids," by Francis E. Nipher, of St. Louis, Mo. The liquid with any desired electrode is placed in the arm of a Wheatstone bridge. Between the bridge and liquid is placed a commutator that does not cause jumping of the brushes. This prevents polarization at the electrodes. In case the resistance of a battery is to be determined, the measuring current does not affect the battery, and the battery current does not disturb the balance of the bridge.

The instrument is standardized by measuring any set of metal or carbon resistances first with the commutator at rest and then with the commutator in motion. The resistance of the contact itself can be determined by known methods. During part of the revolution the resistance to be measured is cut out or short-circuited as the brushes are in contact with both bars of the commutator. The relative duration for such short-circuiting depends on the angle of the split in the commutator and the width of the brushes. It can be varied by using double brushes with variable lead. The best arrangement is one in which we have a double commutator mounted on a shaft so arranged that the brushes of one commutator may be given any desired lead on the other, the two commutators being connected in multiple. The angle of lead is determined by means of a graduated circle and vernier. The above arrangement, it was thought, could be used in any cases where polarization is liable to take place, as in measuring the resistances of underground wires, etc. Results so far as reached showed a very close agreement with previously known methods.

(3) "A New Self-Regulating Photometer," read by John A. Brashear, of Pittsburgh, Pa. This was a rotating disc photometer made, in the first place, at the request of Prof. Langley, for determining the light intensity of the corona. It consists of four discs revolving close together on one axis and having open sectors which can be more or less open, according to the positions of the discs in reference to each other. By a simple method shown by Mr. Brashear this angular opening can be varied while the discs are in rapid rotation and noted. In the drawings shown 70 per cent. of the light could be allowed to pass. The great advantage was the quickness of reading, a very essential thing in many cases.

(4) "Report on the Velocity of Light in a Magnetic Field," by Edward W. Morley, of Cleveland, O., and Henry T. Eddy, of Cincinnati. Two years ago, in a paper read before the American Association, Professor Eddy showed that if the Hall effect were true and also the accepted Maxwell theory of light, there must be a difference in the velocity of light in and out of a magnetic field. The council of the American Association for the Advancement of Science appropriated $250 for the investigation. The results were very small and indecisive. A variation in the density of the bisulphide of carbon lead to great complications. The investigation is to be continued by Professor Morley with an increased magnetic field, the American Association for the Advancement of Science having made an extra appropriation for that purpose.

Following this interesting report was the only paper read bearing directly on electrical engineering.

(5) "Discussion of the formula indicating the work of an electric motor," by G. W. Hough, of Evanston, Ill. The formula is $w = \frac{e\ (E - e)}{R}$, as used by Prof. S. P. Thompson and Gisbert Kapp. Müller-Pouillet gives a similar expression [w = work of motor, E = E. M. F., e = counter E. M. F., R = whole resistance.] The formula may be determined directly from the expression for opposing batteries.

The author claims to show that this formula does *not* represent the condition of a circuit when the counter E. M. F. (e) is being manufactured by this expenditure of mechanical energy. Experiments at the Northwestern University are cited. Then follows the development of a formula according to S. P. Thompson's line of argument, and the development of a formula showing the amount of energy required to bring a motor from a state of rest to a given velocity, and the bearing this formula has on the mathematical law of efficiency.

(6) "Electrical Oscillations in Air," by Professor John Trowbridge and W. C. Sabine. This paper has already been presented to the American Academy of Arts and Sciences, May 28, 1890, and is to appear in the "Proceedings" of that Society, on pages 109-123.

(7) "The Specific Inductive Capacity of Electrolytes," by E. B. Rosa, of Baltimore, Md. Electrolytes such as water, alcohol and certain alcohol derivatives and other liquids have an apparent specific inductive capacity varying from 5 to 30, and in case of water amounting to 75. Maxwell's electromagnetic theory of light requires that $K = \mu^2$, *i. e.:* the specific inductive capacity should equal the square of the index of refraction for light. The question then arises, is the value of K for these liquids only an *apparent* specific inductive capacity, or is it a real specific inductive capacity, and their cases exceptions to Maxwell's rule? The author has measured the force exerted between two electrodes in an electrolytic cell under circumstances varied as follows: (1) varying potential; (2) varying distance between electrodes; (3) varying conductivity by changing purity; (4) varying temperature; (5) varying speed of alternation of currents; and the results seem to show that conducting liquids have a *real* specific inductive capacity just as non-conductors. The apparent exception to Maxwell's rule is explained by the great difference in periods of the forces acting in the case of the action of light, 10^{-15} sec., and of electrical stresses in the experimental measurements of K, and experiments show that in all probability if we could command electrical forces alternating 10^{15} times per second, the value of K would be, perhaps, 2 instead of 75, and hence $= \mu^2$.

(8) "Plan for a New Resistance Box," by A. L. Avery, Rochester, N. Y. The author proposes a method of connecting the coils in one of Prof. Anthony's resistance boxes which will render about one-half of the coils unnecessary.

(9) A paper on "An Ampère-meter for Feeble Alternating Currents: the Farado-Meter," by Wellington Adams, of St. Louis, Mo., was omitted on account of the absence of the author. The meter, it was learned, was claimed to be useful for medical currents.

Electric Lighting in Japan.*

"Five years ago," says the Jiji Shimpo, "the electric light began to be used in Japan. In the spring of 1886 the Electric Light Company of Tokyo was formed, and received a commission to fit up apparatus in the printing office of the *Official Gazette* and in the Officers' College of the War Department. The Cotton Spinning Company of Osaka quickly followed suit, and by degrees people began to believe in the advantages of the light. The Tokyo Electric Light Company soon opened a second and yet a third office, and after it had been commissioned to provide the Palace with lights other companies were formed in Kyoto, Magoya and Kobe. The cotton spinning mills in different localities vied with one another to employ the light, while in Tokyo the field was entered by two additional companies, the Shinagawa Dento-Kaisha and the Nippon Dento-Kaisha, and there is talk of yet another being added under the name of the Teikoku Dento-Kaisha.

Outside Tokyo we have the Hokkaido Company, the Hakodate Company, the Thizuoka Company, the Nagano Company, the Kumamoto Company, the Nagasaki Company, the Yokohama Company, the Hakata Company and the Hiroshima Company, all of which have received official sanction. Moreover, projects are on foot for the formation of other companies in Kanagawa, Otsu, Mito and Tendai. If things go on at this rate, the progress of electric lighting in Japan will soon be something astonishing."

Our contemporary then gives a table showing the numbers of lights actually fitted up or in process of being installed The record stands thus:

		Capacity of station.	Number of lights actually in use.
Tokyo Electric Light Company,	First station	6,200	4,000
" " " "	Second "	2,200	600
" " " "	Third "	2,200	1,600
" " " "	Fifth "	2,200	1,300
Kyoto Company		2,200	900
Kobe "		2,200	1,000
Asaka "		3,500	900
Nagoya "		1,600	700

Although not yet in use, permission has been obtained for the installation of the following plants: Nagoya, 1,000; Kumamoto, 1,000; Nagasaki, 1,000; Hakodate, 1,000; Yokohama, 500; Hiroshima, 1,200; Thizuoka, 1,500; Hokkaido, 2,600; Nügata, 1,500. Then follows a list of the number of lights in use at private houses, factories, etc., from which we learn that there are 150 at Mr. Twasaki's Fukagawa residence; 400 at the Kane-gafuchi spinning mill; 250 at the Tokyo spinning mill; 500 at the Imperial University; 500 at the Cotton and Silk Spinning Company; 330 at the Officers' School; 130 at the *Official Gazette;* 150 at the Department of Communications, and many others. It is plain, therefore, that lighting by electricity has fairly established itself in Japan.

The Albany Street Railway Power Station.

On this page illustrations are given of the details of the very successful power station that operates the Albany Railroad. It is an admirable example of the most modern type of equipment and apparatus. The system used in Albany, as is well known to our readers, is the Thomson-Houston, and it is gradually being extended to include a considerable number of lines. The grades are severe, one of them being for 500 feet as steep as eight and a half per cent. The car equipment is admirable. The Manier truck, fitted with improved roller bearings, is used to support two standard Thomson-Houston motors when the cars are finally equipped. Thirty-two cars are now in regular use. The power house—which is shown very completely in our illustration—is on Pearl street, near Third avenue, Albany. It is a large brick building, 94 feet front and 120 feet deep, and though it has but one story it is exceedingly roomy and airy, being 21 feet high in the clear to the bottom of the girders that support the roof. The plant consists of twelve 80,000-watt Thomson-Houston compound wound generators, driven by McIntosh & Seymour engines. These are of the compound condensing type, and they are intended to develop 250 h. p. at 200 revolutions per minute. They are a special class of engine built for railway service, and are made extra heavy, with specially massive driving wheels, the pair weighing 14,000 pounds. The dimensions of the cylinders are as follows: The high-pressure cylinder is 15 inches in diameter. 17 inches stroke; low-pressure cylinder 23 inches in diameter with the same stroke. They have run throughout very successfully and have given an astonishingly small amount of trouble of any kind. The first of our three cuts gives a sectional view of the power house, showing the arrangement of engines, boilers, and dynamos. The foundations for the machinery are, it will be seen, exceptionally heavy. They are built of hard burned brick and Portland cement, and raised on a substructure of two feet of concrete. The result of this unusual care is remarkable freedom from vibration of every sort. It will be observed

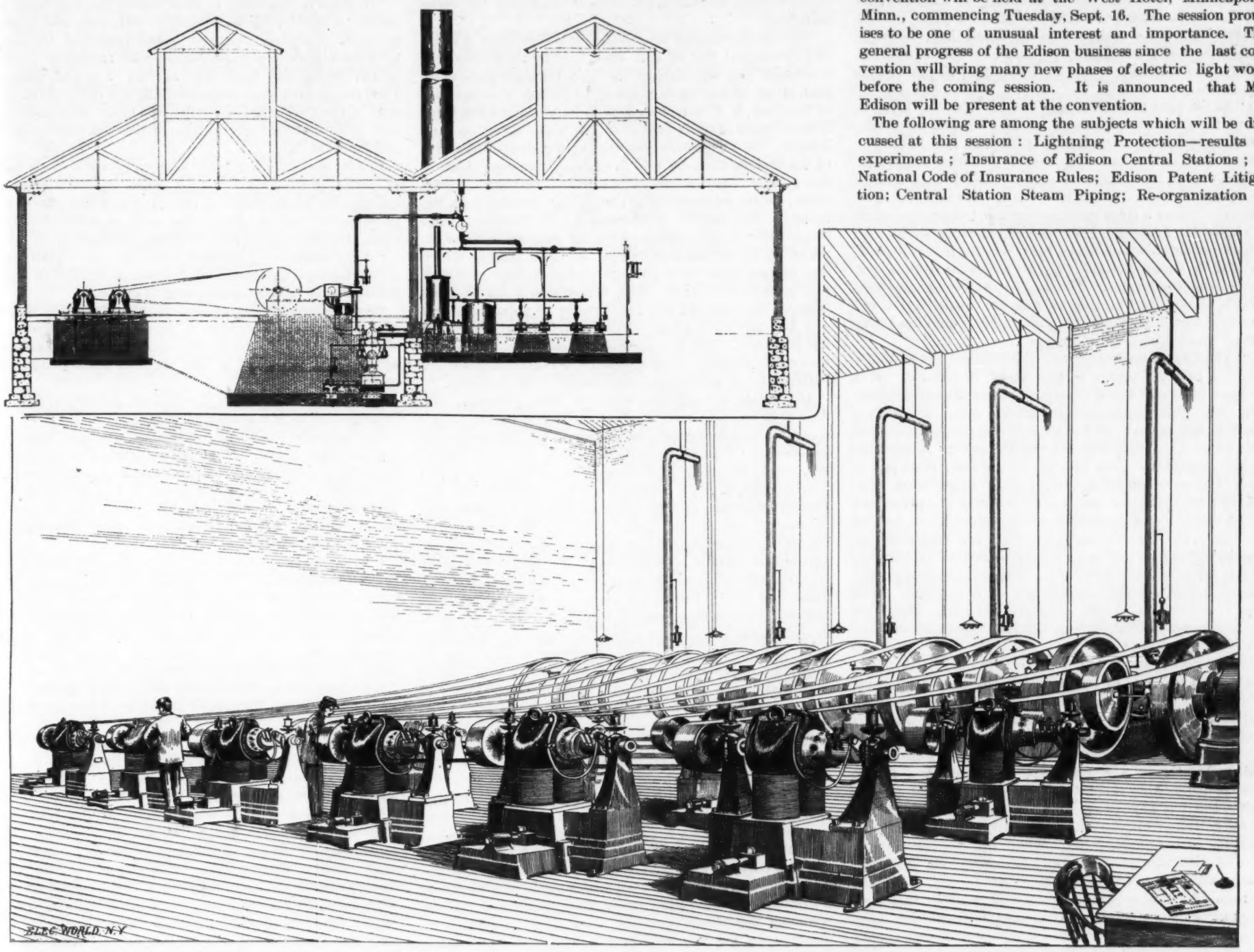
* Extract from the Japan *Daily Mail.*

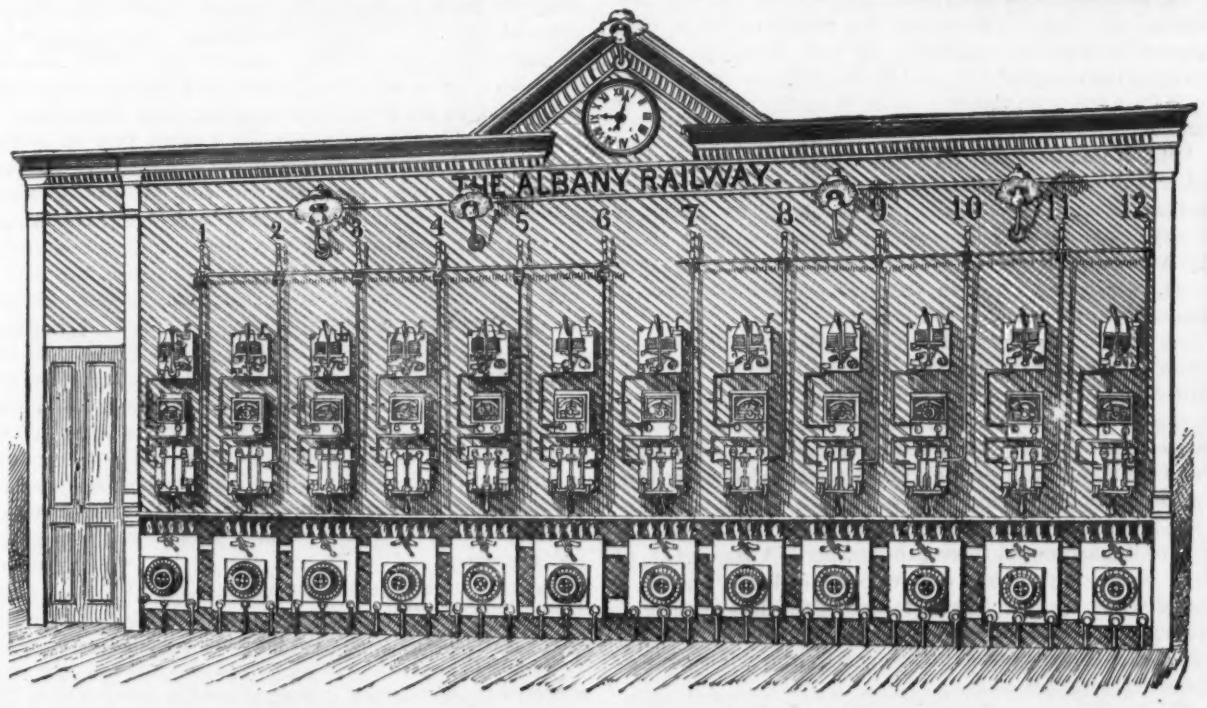
that the boiler room is separated by a brick wall from the room containing the engines and dynamos, and that these latter are directly belted, each driving two generators—one from either belt wheel.

The cut also shows the interior of the dynamo room, with the long double line of generators, each belted to its engine. The dynamo room is a model of neatness. It is well ventilated and well lighted, and the arrangement of the machines permits the readiest access to every part of them, thus facilitating the careful attention that is so important a feature in electrical work. The other half of the power house contains the battery of boilers, each of 125 h. p. capacity. They are of the well-known water tube type made by the Babcock & Wilcox Company. This form of boiler has stood the severest tests, and is very largely used, both in this country and abroad, for electrical purposes.

A word concerning the arrangement of the boilers may not be out of place here. The boiler is suspended entirely independent of the brick work from wrought iron girders which rest on iron columns. In this way it is unlikely to be sprung by unequal expansion, and the brick work can be repaired or removed, if necessary, without disturbing or injuring the boiler. A large door in front permits ready access to the tubes for cleaning or repairs, while the rapid circulation of water is said to in great measure prevent the deposits which are so fatal if allowed to go on without attention. The steam is drawn from the capacious drums at the tops of the boilers, and is very thoroughly dried.

The water tube style of construction here followed allows the carrying of very high pressures, as is often desirable for compound or triple expansion engines. The battery of boilers is admirably arranged—all the small pipes connected with the feeding and blowing-off arrangements are placed in a brick conduit under the floor of the boiler room and covered with iron plates, and the smoke flue is also underground. The smoke-stack is of quarter-inch, iron, six feet in diameter at the base and six feet six inches at the top, the six inches increase being accounted for by the lapping of the successive tiers of plates from which the stack is made. Provision has been made for readily reaching the top of the stack at any time, if necessary. Our cut of the switchboard, due to the courtesy of the *Street Railway Journal*, shows a beautifully finished affair, 30 feet long containing ample space for the 12 independent sets of switches and measuring instruments belonging to the different dynamos. It is placed flush with the front wall in the center of the station, facing the machinery, and its back is accessible by a door leading to the alcove of which it forms the front. The 12 sets of instruments are precisely alike, each one consisting of an automatic circuit breaker, an ammeter, a three pole switch and a rheostat. The switch allows the cutting out and in of any one of the dynamos in the ordinary course of operation. The automatic circuit breaker is purely a safety device in case of anything going wrong on the line of the dynamo, so that if a ground occurs, for example, affecting a particular machine it will be at once cut out. Besides the apparatus regularly on the switchboard, a special set of switches connected with a voltmeter is provided, so that any one of the generators can be connected with it at pleasure. This is a very necessary precaution, especially where, as in this station, compound wound generators are to be used, which are worked in parallel and consequently require unusually careful adjustment of the electromotive force. The entire installation was arranged by Mr. L. H. McIntire, of the Thomson-Houston Company, and he has certainly been successful in equipping one of the best power plants to be found in the country. The entire road is a model of an electric street railway plant, and its success from the moment of its being first put into operation is a sufficient attest of the care that has been taken in every detail.





SECTION, INTERIOR VIEW, AND SWITCHBOARD OF THE ALBANY POWER STATION.

The Association of Edison Illuminating Companies.

A circular has been issued by Mr. W. J. Jenks, the secretary of this association, announcing that the annual convention will be held at the West Hotel, Minneapolis, Minn., commencing Tuesday, Sept. 16. The session promises to be one of unusual interest and importance. The general progress of the Edison business since the last convention will bring many new phases of electric light work before the coming session. It is announced that Mr. Edison will be present at the convention.

The following are among the subjects which will be discussed at this session: Lightning Protection—results of experiments; Insurance of Edison Central Stations; A National Code of Insurance Rules; Edison Patent Litigation; Central Station Steam Piping; Re-organization of Edison Interests; Grounding the Neutral Wire in Three Wire Systems.

In case a sufficient number of applications are received by the secretary a special Wagner vestibule sleeper will be secured and attached to the New York Central limited express for Chicago, leaving the Grand Central Depot, New York City, on Sunday, Sept. 14, at 9:50 A. M. This train is due in Chicago at 10:10 A. M. on Monday, and an opportunity will be afforded for a visit to the Edison headquarters and other points of interest in the city, the train for Minneapolis leaving on the Chicago, Burlington & Quincy Railroad at 5:30 P. M., and arriving in Minneapolis Tuesday, at 7 A. M.

The Electro-magnet.*

BY PROF. SILVANUS P. THOMPSON, D. SC., B. A., M. I. E. E.

Sturgeon's further work during the next three years is best described in his own words:

"It does not appear that any very extensive experiments were attempted to improve the lifting power of electro-magnets, from the time that my experiments were published in the 'Transactions of the Society of Arts, etc.,' for 1825, till the latter part of 1828. Mr. Watkins, philosophical instrument maker, Charing Cross, had, however, made them of much larger size than any which I had employed, but I am not aware to what extent he pursued the experiment.

"In the year 1828, Professor Moll, of Utrecht, being on a visit to London, purchased of Mr. Watkins an electro-magnet weighing about 5 pounds—at that time, I believe, the largest which had been made. It was of round iron, about one inch in diameter, and furnished with a single copper wire twisted round it 83 times. When this magnet was excited by a large galvanic surface, it supported about 75 pounds. Professor Moll afterwards prepared another electro-magnet, which, when bent, was 12½ inches high, 2½ inches in diameter, and weighed about 26 pounds, prepared, like the former, with a single spiral conducting wire. With an acting galvanic surface of 11 square feet, this magnet would support 154 pounds, but would not lift an anvil which weighed 200 pounds.

"The largest electro-magnet which I have yet [1832] exhibited in my lectures weighs about 16 pounds. It is formed of a small bar of soft iron, 1¼ inches across each side; the cross piece which joins the poles is from the same rod of iron, and about 3¾ inches long. Twenty separate strands of copper wire, each strand about 50 feet in length, are coiled around the iron, one above another, from pole to pole, and separated from each other by intervening cases of silk; the first coil is only the thickness of one ply of silk from the iron; the twentieth, or outermost, about half an inch irom it. By this means the wires are completely insulated from each other without the trouble of covering them with thread or varnish. The ends of wire project about 2 feet for the convenience of connection. With one of my small cylindrical batteries, exposing about 150 square inches of total surface, this electro-magnet supports 400 pounds. I have tried it with a larger battery, but its energies do not seem to be so materially exalted as might have been expected by increasing the extent of galvanic surface. Much depends upon a proper acid solution; good nitric or nitrous acid, with about six or eight times its quantity of water, answers very well. With a new battery of the above dimensions and a strong solution of salt and water, at a temperature of 190 degrees Fahr., the electro-magnet supported between 70 and 80 pounds when the first 17 coils only were in the circuit. With the three exterior coils alone in the circuit, it would just support the lifter or cross piece. When the temperature of the solution was between 40 and 50 degrees, the magnetic force excited was comparatively very feeble. With the innermost coil alone and a strong acid solution this electro-magnet supports about 100 pounds: with the four outermost wires about 250 pounds. It improves in power with every additional coil until about the twelfth, but not perceptibly any further; therefore, the remaining eight coils appear to be useless, although the last three, independently of the innermost 17, and at the distance of half an inch from the iron, produce in it a lifting power of 75 pounds.

"Mr. Marsh has fitted up a bar of iron much larger than mine with a similar distribution of the conducting wires to that devised and so successfully employed by Professor Henry. Mr. Marsh's electro-magnet will support about 560 pounds when excited by a galvanic battery similar to mine. These two, I believe, are the most powerful electro-magnets yet produced in this country.

"A small electro-magnet, which I also employ on the lecture table, and the manner of its suspension, is represented by Fig. 3, Plate VI.† The magnet is of cylindric rod iron and weighs four ounces; its poles are about a quarter of an inch asunder. It is furnished with six coils of wire in the same manner as the large electro-magnet before described, and will support upward of 50 pounds.

"I find a triangular gin very convenient for the suspension of the magnet in these experiments. A stage *A A*, of thin board, supporting two wooden dishes, *C* and *Z*, is fastened, at a proper height, to two of the legs of the gin. Mercury is placed in these vessels, and the dependent amalgamated extremities of the conducting wires dip into it—one into each portion.

"The vessels are sufficiently wide to admit of considerable motion of the wires in the mercury without interrupting the contact, which is sometimes occasioned by the swinging of the magnet and attached weight. The circuit is completed by other wires, which connect the battery with these two portions of mercury. When the weight is supported as in the figure, if an interruption be made by removing either of the connecting wires, the weight instantaneously drops on the table. The large magnet I suspend in the same way on a larger gin; the weights which it supports are placed one after another on a square board, suspended by means of a cord at each corner from a hook in the cross piece, which joins the poles of the magnet.

"With a new battery and a solution of salt and water, at a temperature of 190 degrees Fahr., the small electro-magnet, Fig. 3, supports 16 pounds."

In 1840, after Sturgeon had removed to Manchester, where he assumed the management of the "Victoria Gallery of Practical Science," he continued his work, and in the seventh memoir in his series of researches he wrote as follows:

"The electro-magnet belonging to this Institution is made of a cylindrical bar of soft iron, bent into the form of a horseshoe magnet, having the two branches parallel to each other and at the distance of 4.5 inches. The diameter of the iron is 2.75 inches; it is 18 inches long when bent. It is surrounded by 14 coils of copper wire, seven on each branch. The wire which constitutes the coils is one-twelfth of an inch in diameter, and in each coil there are about 70 feet of wire. They are united in the usual way with branch wires, for the purpose of conducting the currents from the battery. The magnet was made by Mr. Nesbit. . . . The greatest weight sustained by the magnet in these experiments is 12¾ hundredweight, or 1,386 pounds, which was accomplished by 16 pairs of plates, in four groups of four pairs in series each. The lifting power by 19 pairs in series was considerably less than by 10 pairs in series; and but very little greater than that given by one cell or one pair only. This is somewhat remarkable, and shows how easily we may be led to waste the magnetic powers of batteries by an injudicious arrangement of its elements."*

At the date of Sturgeon's work the laws governing the flow of electric currents in wires were still obscure. Ohm's epoch-making enunciation of the law of the electric circuit appeared in "Poggendorff's Annalen" in the very year of Sturgeon's discovery, 1825, though his complete book appeared only in 1827, and his work, translated by Dr. Francis into English, only appeared (in Taylor's "Scientific Memoirs," vol. ii.) in 1841. Without the guidance of Ohm's law it was not strange that even the most able experimenters should not understand the relations between battery and circuit which would give them the best effects. These had to be found by the painful method of trial and failure. Pre-eminent among those who tried was Prof. Joseph Henry, then of the Albany Institute in New York, later of Princeton, N. J., who succeeded in effecting an important improvement. In 1828, led on by a study of the "multiplier" (or galvanometer), he proposed to apply to electro-magnetic apparatus the device of winding them with a spiral coil of wire "closely turned on itself," the wire being of copper from one-fortieth to one-twenty-fifth of an inch in diameter, covered with silk. In 1831 he thus describes† the results of his experiments:

"A round piece of iron, about one-quarter of an inch in diameter, was bent into the usual form of a horseshoe, and instead of loosely coiling around it a few feet of wire, as is usually described, it was tightly wound with 35 feet of wire covered with silk, so as to form about 400 turns; a pair of small galvanic plates, which could be dipped into a tumbler of diluted acid, was soldered to the ends of the wire and the whole mounted on a stand. With these small plates the horseshoe became much more powerfully magnetic than another of the same size, and wound in the same manner, by the application of a battery composed of 28 plates of copper and zinc, each 8 inches square. Another convenient form of this apparatus was contrived by winding a straight bar of iron 9 inches long with 35 feet of wire and supporting it horizontally on a small cup of copper containing a cylinder of zinc; when this cup, which served the double purpose of a stand and the galvanic element, was filled with dilute acid the bar became a portable electro-magnet. These articles were exhibited to the Institute in March, 1829. The idea afterwards occurred to me that a sufficient quantity of galvanism was furnished by the two small plates to develop, by means of the coil, a much greater magnetic power in a larger piece of iron. To test this, a cylindrical bar of iron, half an inch in diameter, and about 10 inches long, was bent into the shape of a horseshoe, and wound with 30 feet of wire; with a pair of plates containing only 2½ square inches of zinc it lifted 15 pounds avoirdupois. At the same time a very material improvement in the formation of the coil suggested itself to me on reading a more detailed account of Professor Schweigger's galvanometer, and which was also tested with complete success upon the same horseshoe; it consisted in using several strands of wire, each covered with silk, instead of one. Agreeably to this construction a second wire, of the same length as the first, was wound over it, and the ends soldered to the zinc and copper in such a manner that the galvanic current might circulate in the same direction in both, or, in other words, that the two wires might act as one; the effect by this addition was doubled, as the horseshoe, with the same plates before used, now supported 28 pounds.

"With a pair of plates 4 inches by 6 inches, it lifted 39 pounds, or more than 50 times its own weight.

"These experiments conclusively proved that a great development of magnetism could be effected by a very small galvanic element, and also that the power of the coil was materially increased by multiplying the number of wires without increasing the number of each."‡

Not content with these results, Professor Henry pushed forward on the line he had thus struck out. He was keenly desirous to ascertain how large a magnetic force he could produce when using only currents of such a degree of smallness as could be transmitted through the comparatively thin copper wires, such as bell-hangers use. During the year 1830 he made great progress in this direction, as the following extracts show:

"In order to determine to what extent the coil could be applied in developing magnetism in soft iron, and also to ascertain, if possible, the most proper length of the wires to be used, a series of experiments was instituted jointly by Dr. Philip Ten Eyck and myself. For this purpose 1,060 feet (a little more than one-fifth of a mile) of copper wire of the kind called bell-wire, .045 of an inch in diameter, were stretched several times across the large room of the Academy.

"*Experiment* 1.—A galvanic current from a single pair of plates of copper and zinc 2 inches square was passed through the whole length of the wire, and the effect on a galvanometer noted. From the mean of several observations, the deflection of the needle was 15 degrees.

"*Experiment* 2.—A current from the same plates was passed through half the above length, or 530 feet of wire; the deflection in this instance was 21 degrees.

"By a reference to a trigonometrical table, it will be seen that the natural tangents of 15 degrees and 21 degrees are very nearly in the ratio of the square roots of 1 and 2, or of the relative lengths of the wires in these two experiments.

"The length of the wire forming the galvanometer may be neglected, as it was only 8 feet long.

"*Experiment* 3.—The galvanometer was now removed, and the whole length of the wire attached to the ends of the wire of a small soft iron horseshoe, a quarter of an inch in diameter, and wound with about 8 feet of copper wire with a galvanic current from the plates used in experiments 1 and 2. The magnetism was scarcely observable in the horseshoe.

"*Experiment* 4.—The small plates were removed and a battery composed of a piece of zinc plate 4 inches by 7 inches, surrounded with copper, was substituted. When this was attached immediately to the ends of the 8 feet of wire wound round the horseshoe, the weight lifted was 4½ pounds, when the current was passed through the whole length of wire (1,060 feet), it lifted about half an ounce.

"*Experiment* 5.—The current was passed through half the length of wire (530 feet) with the same battery; it then lifted two ounces.

"*Experiment* 6.—Two wires of the same length as in the last experiment were used, so as form two strands from the zinc and copper of the battery; in this case the weight lifted was four ounces.

"*Experiment* 7.—The whole length of the wire was attached to a small trough on Mr. Cruickshanks' plan, containing 25 double plates, and presenting exactly the same extent of zinc surface to the action of the acid as the battery used in the last experiment. The weight lifted in this case was 8 ounces; when the intervening wire was removed, and the trough attached directly to the ends of the wire surrounding the horseshoe, it lifted only 7 ounces. . . .

"It is possible that the different states of the trough with respect to dryness may have exerted some influence on this remarkable result; but that the effect of a current from a trough, if not increased, is but slightly diminished in passing through a long wire is certain. . . .

"But be this as it may, the fact that the magnetic action of a current from a trough is, at least, not sensibly diminished by passing through a long wire is directly applicable to Mr. Barlow's project of forming an electro-magnetic telegraph; and it is also of material consequence in the construction of the galvanic coil. From these experiments it is evident that in forming the coil we may either use one very long wire, or several shorter ones, as the circumstances may require; in the first case, our galvanic combinations must consist of a number of plates, so as to give 'projectile force;' in the second it must be formed of a single pair.

"In order to test on a large scale the truth of these preliminary results, a bar of soft iron, 2 inches square and 20 inches long, was bent into the form of a horseshoe, 9½ inches high. The sharp edges of the bar were first a little rounded by the hammer—it weighed 21 pounds; a piece of iron from the same bar, weighing 7 pounds, was filed perfectly flat on one surface, for an armature or lifter; the extremities of the legs of the horseshoe were also truly ground to the surface of the armature; around this horseshoe 540 feet of copper bell-wire were wound in 9 coils of 60 feet each; these coils were not continued around the whole length of the bar, but each strand of wire, according to the principle before mentioned, occupied about 2 inches, and was coiled several times backward and forward over itself; the several ends of the wires were left projecting and all numbered, so that the first and last end of each strand might be readily distinguished. In this manner we formed an experimental magnet on a large scale, with which several combinations of wire could be made by merely uniting the different projecting ends. Thus, if the second end of the first wire be soldered to the first end of the second wire, and so on through all the series, the whole will form a continuous coil of one long wire.

"By soldering different ends the whole may be formed

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* Continued from THE ELECTRICAL WORLD, Aug. 30, 1890.
† This is the reference to the plate in Sturgeon's "Scientific Researches."

* Sturgeon's "Scientific Researches," p. 188.
† Silliman's "American Journal of Science," Jan. 1831, xix., p. 400.
‡ "Scientific Writings of Joseph Henry," p. 39.

in a double coil of half the length, or into a triple coil of one-third the length, etc. The horseshoe was suspended in a strong rectangular wooden frame, 3 feet 9 inches high and 20 inches wide; an iron bar was fixed below the magnet, so as to act as a lever of the second order; the different weights supported were estimated by a sliding weight in the same manner as with a common steel-yard (see sketch). In the experiments immediately following (all weights being avoirdupois) a small single battery was used, consisting of two concentric copper cylinders with zinc between them; the whole amount of zinc surface exposed to the acid from both sides of the zinc was two-fifths of a square foot; the battery required only half a pint of dilute acid for its submersion.

"*Experiment* 8.—Each wire of the horseshoe was soldered to the battery in succession, one at a time; the magnetism develcped by each was just sufficient to support the weight of the armature, weighing 7 pounds.

"*Experiment* 9.—Two wires, one on each side of the arch of the horseshoe, were attached; the weight lifted was 145 pounds.

"*Experiment* 10.—With two wires, one from each extremity of the legs, the weight lifted was 200 pounds.

"*Experiment* 11.—With three wires, one from each extremity of the legs and one from the middle of the arch, the weight supported was 300 pounds.

"*Experiment* 12.—With four wires, two from each extremity, the weight lifted was 500 pounds and the armature; when the acid was removed from the zinc, the magnet continued to support for a few minutes 130 pounds.

"*Experiment* 13.—With six wires the weight supported was 570 pounds; in all these experiments the wires were soldered to the galvanic element; the connection in no case was formed with mercury.

"*Experiment* 14.—When all the wires (nine in number) were attached, *the maximum weight lifted was 650 pounds*, and this astonishing result, it must be remembered, was produced by a battery containing only two-fifths of a square foot of zinc surface, and requiring only half a pint of dilute acid for its submersion.

"*Experiment* 15.—A small battery, formed with a plate of zinc 12 inches long and 6 inches wide, and surrounded by copper, was substituted for the galvanic elements used in the last experiment; the weight lifted in this case was 750 pounds.

"*Experiment* 16.—In order to ascertain the effect of a very small galvanic element on this large quantity of iron, a pair of plates exactly one inch square was attached to all the wires; the weight lifted was 85 pounds.

"The following experiments were made with wires of different lengths on the same horseshoe.

"*Experiment* 17.—With six wires, each 30 feet long, attached to the galvanic element, the weight lifted was 375 pounds.

"*Experiment* 18.—The same wires used in last experiment were united so as to form three coils of 60 feet each; the weight supported was 290 pounds. This result agrees nearly with that of experiment 11, though the same individual wires were not used; from this it appears that six short wires are more powerful than three of double the length.

"*Experiment* 19.—The wires used in experiment 10, but united so as to form a single coil of 120 feet of wire, lifted 60 pounds; while in experiment 10 the weight lifted was 200 pounds. This is a confirmation of the result in the last experiment. . . .

"In these experiments a fact was observed which appears somewhat surprising: when the large battery was attached, and the armature touching both poles of the magnet, it was capable of supporting more than 700 pounds, but when only one pole is in contact it did not support more than 5 or 6 pounds, and in this case we never succeeded in making it lift the armature (weighing 7 pounds). This fact may perhaps be common to all large magnets, but we have never seen the circumstance noticed of so great a difference between a single pole and both. . . .

"A series of experiments was separately instituted by Dr. Ten Eyck, in order to determine the maximum development of magnetism in a small quantity of soft iron.

"Most of the results given in this paper were witnessed by Dr. L. C. Beck, and to this gentleman we are indebted for several suggestions, and particularly that of substituting cotton well waxed for silk thread, which in these investigations became a very considerable item of expense. He also made a number of experiments with iron bonnet-wires, which, being found in commerce already wound, might possibly be substituted in place of copper. The result was that with very short wire the effect was nearly the same as with copper, but in coils of long wire with a small galvanic element it was not found to answer. Dr. Beck also constructed a horseshoe of round iron one inch in diameter, with four coils on the plan before described. With one wire it lifted 30 pounds, with two wires 60 pounds, with three wires 85 pounds, and with four wires 112 pounds. While we were engaged in these investigations, the last number of the *Edinburgh Journal of Science* was received containing Professor Moll's paper on 'Electro-magnetism.' Some of his results are in a degree similar to those here described; his object, however, was different, it being only to induce strong magnetism on soft iron with a powerful galvanic battery. The principal object in these experiments was to produce the greatest magnetic force with the smallest quantity of galvanism. The only effect Professor Moll's paper has had over these investigations has been to hasten their publication; the principle on which they were instituted was known to us nearly two years since, and at that time exhibited to the Albany Institute."*

In the next number of *Silliman's Journal* (April, 1831), Professor Henry gave "an account of a large electro-magnet made for the laboratory of Yale College." The core of the armature weighed 59½ pounds; it was forged under Henry's own direction, and wound by Dr. Ten Eyck. This magnet, wound with 26 strands of copper bell-wire of total length of 728 feet, and excited by two cells which exposed nearly 4⅞ square feet of surface, readily supported on its

FIG. 6.—HENRY'S EXPERIMENTAL ELECTRO-MAGNET.

armature, which weighed 23 pounds, a load of 2,063 pounds.

Writing in 1867 of his earlier experiments, Henry speaks† thus of his ideas respecting the use of additional coils on the magnet and the increase of battery power:

"To test these principles on a larger scale the experimental magnet was constructed, which is shown in Fig. 6. In this a number of compound helices were placed on the same bar, their ends left projecting, and so numbered that they could all be united into one long helix, or variously combined in sets of lesser length.

"From a series of experiments with this and other magnets, it was proved that in order to produce the greatest amount of magnetism from a battery of a single cup a number of helices is required; but when a compound battery is used then one long wire must be employed, making many turns around the iron, the length of wire, and consequently the number of turns, being commensurate with the projectile power of the battery.

"In describing the results of my experiments, the terms 'intensity' and 'quantity' magnets were introduced to avoid circumlocution, and were intended to be used merely in a technical sense. By the intensity magnet I designated a piece of soft iron, so surrounded with wire that its magnetic power could be called into operation by an intensity battery; and by a quantity magnet, a piece of iron so surrounded by a number of separate coils that its magnetism could be fully developed by a quantity battery.

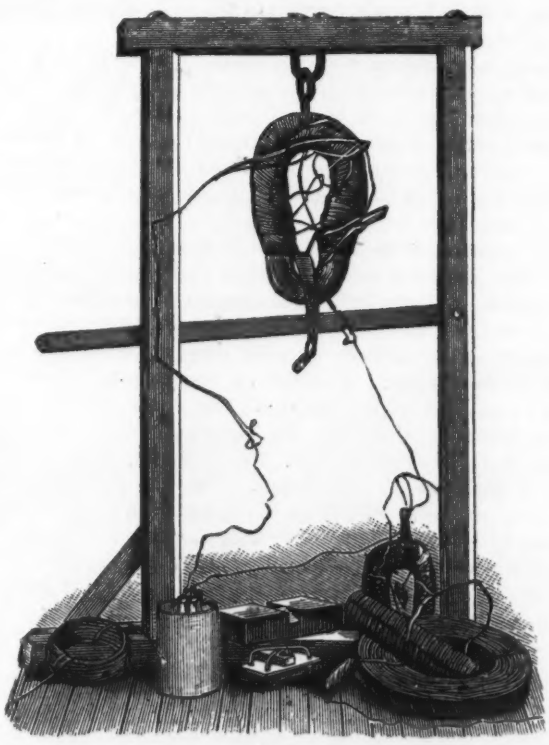


FIG. 5.—HENRY'S ELECTRO-MAGNET.‡

"I was the first to point out this connection of the two kinds of the battery with the two forms of the magnet, in my paper, in *Silliman's Journal*, January, 1831, and clearly to state that when magnetism was to be developed by means of a compound battery one long coil must be employed, and when the maximum effect was to be produced by a single battery a number of single strands should be used. . . . Neither the electro-magnet of Sturgeon nor any electro-magnet ever made previous to my investigations was applicable to transmitting power to a distance. . . . The electro-magnet made by Sturgeon, and copied by Dana, of New York, was an imperfect quantity magnet, the feeble power of which was developed by a single battery."

* "Scientific writings of Joseph Henry," p. 49.

† Statement in relation to the history of the electro-magnetic telegraph, from the Smithsonian Annual Report for 1857, p. 99.

‡ This figure, copied from the *Scientific American*, Dec. 11, 1880, represents Henry's electro-magnet still preserved in Princeton College. The other apparatus at the foot, including a current-reverser, and the ribbon-coil used in the famous experiments on secondary and tertiary currents, were mostly constructed by Henry's own hands.

Finally, Henry* sums up his own position as follows:

"1. Previous to my investigations the means of developing magnetism in soft iron were imperfectly understood, and the electro-magnet which then existed was inapplicable to transmissions of power to a distance.

"2. I was the first to prove by actual experiment that in order to develop magnetic power at a distance a galvanic battery of 'intensity' must be employed to project the current through the long conductor, and that a magnet surrounded by many turns of one long wire must be used to receive this current.

"3. I was the first to actually magnetize a piece of iron at a distance, and to call attention to the fact of the applicability of my experiments to the telegraph.

"4. I was the first to actually sound a bell at a distance by means of the electro-magnet.

"5. The principles I had developed were applied by Dr. Gale to render Morse's machine effective at a distance."

Though Henry's researches were published in 1831, they were for some years almost unknown in Europe. Until April, 1837, when Henry himself visited Wheatstone at his laboratory at King's College, the latter did not know how to construct an electro-magnet that could be worked through a long wire circuit. Cooke, who became the co-adjutor of Wheatstone, had originally come to him to consult him,† in February, 1837, about his telegraph and alarum, the electro-magnets of which, though they worked well on short circuits, refused to work when placed in circuit with even a single mile of wire. Wheatstone's own account‡ of the matter is extremely explicit: "Relying on my former experience, I at once told Mr. Cooke that his plan would not and could not act as a telegraph, because sufficient attractive power could not be imparted to an electro-magnet interposed in a long circuit; and, to convince him of the truth of this assertion, I invited him to King's College to see the repetition of the experiments on which my conclusion was founded. He came, and after seeing a variety of voltaic magnets, which even with powerful batteries exhibited only slight adhesive traction, he expressed his disappointment."

After Henry's visit to Wheatstone, the latter altered his tone. He had been using, *faute de mieux*, relay circuits to work the electro-magnets of his alarum in a short circuit with a local battery. "These short circuits," he writes, "have lost nearly all their importance and are scarcely worth contending about since *my discovery*" (the italics are our own) "that electro-magnets may be so constructed as to produce the required effects by means of the direct current, even in very long circuits."**

We pass on to the researches of the distinguished physicist of Manchester, whose decease we have lately had to deplore, Mr. James Prescott Joule, who, fired by the work of Sturgeon, made most valuable contributions to the subject. Most of these were published either in Sturgeon's "Annals of Electricity," or in the "Proceedings of the Literary and Philosophical Society of Manchester," but their most accessible form is the republished volume issued five years ago by the Physical Society of London.

In his earliest investigations he was endeavoring to work out the details of an electric motor. The following is an extract from his own account ("Reprint of Scientific Papers," p. 7):

"In the further prosecution of my inquiries, I took six pieces of round bar iron of different diameters and lengths, also a hollow cylinder, one-thirteenth of an inch thick in the metal. These were bent in the U-form, so that the shortest distance between the poles of each was half an inch; each was then wound with 10 feet of covered copper wire, one-fortieth of an inch in diameter. Their attractive powers under like currents for a straight steel magnet, 1¼ inches long, suspended horizontally to the beam of a balance, were, at the distance of half an inch, as follows:

	No. 1. Hollow.	No. 2. Solid.	No. 3. Solid.	No. 4. Solid.	No. 5. Solid.	No. 6. Solid.	No. 7. Solid.
Length round the bend in inches	6	5⅛	2⅜	5⅛	2⅛	5⅛	2¼
Diameter in inches	⅛	⅛	⅛	⅜	⅜	¼	¼
Attraction for steel magnet, in grains	7.5	6.3	5.1	5.0	4.1	4 8	3.6
Weight lifted, in ounces	35	52	92	36	52	20	28

"A steel magnet gave an attractive power of 23 grains, while its lifting power was not greater than 60 ounces.

"The above results will not appear surprising if we consider, first, the resistance which iron presents to the induction of magnetism, and, second, how very much the induction is exalted by the completion of the magnetic circuit.

"Nothing can be more striking than the difference between the ratios of lifting to attractive power at a distance in the different magnets. While the steel magnet attracts with a force of 23 grains and lifts 60 ounces, the electro-magnet No. 3 attracts with a force of only 5.1 grains, but lifts as much as 92 ounces.

"To make a good electro-magnet for lifting purposes: 1st.

* "Scientific Writings of Joseph Henry," vol. ii., p. 435.

† See Mr. Latimer Clark's account of Cooke in Vol. VIII. of "Journal of Society of Telegraph Engineers," p. 374.

‡ W. F. Cooke, "The Electric Telegraph: Was it Invented by Prof. Wheatstone?" 1856-7, part ii., p. 87.

** Ib., p. 95.

Its iron, if of considerable bulk, should be compound. of good quality, and well annealed. 2d. The bulk of the iron should bear a much greater ratio to its length than is generally the case. 3d. The poles should be ground quite true, and fit flatly and accurately to the armature. 4th. The armature should be equal in thickness to the iron of the magnet.

"In studying what form of electro-magnet is best for attraction from a distance, two things must be considered, viz., the length of the iron and its sectional area.

"Now I have always found it disadvantageous to increase the length beyond what is needful for the winding of the covered wire."

These results were announced in March, 1839. In May of the same year he propounded a law of the mutual attraction of two electro-magnets as follows: "The attractive force of two electro-magnets for one another is directly proportional to the square of the electric force to which the iron is exposed; or if E denote the electric current, W the length of wire, and M the magnetic attraction, $M = E^2 W^2$." The discrepancies which he himself observed he rightly attributed to the iron becoming saturated magnetically. In March, 1840, he extended this same law to the lifting power of the horseshoe electro-magnet.

In August, 1840, he wrote to the "Annals of Electricity" on electro-magnetic forces, dealing chiefly with some special electro-magnets for traction. One of these possessed the form shown in Fig. 7. Both the magnet and the iron keeper were furnished with eye-holes for the purpose of suspension and measurement of the force requisite to detach the keeper. Joule thus writes about the experiments:*

"I proceed now to describe my electro-magnets, which I constructed of very different sizes in order to develop any curious circumstance which might present itself. A piece of cylindrical wrought iron, 8 inches long, had a hole one inch in diameter bored the whole length of its axis; one side was planed until the hole was exposed sufficiently to separate the thus formed poles one-third of an inch. Another piece of iron, also 8 inches long, was then planed,

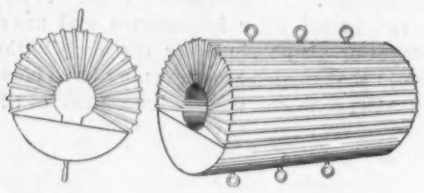


Fig. 7.—Joule's Electro-magnet.

and, being secured with its face in contact with the other planed surface, the whole was turned into a cylinder 8 inches long, 3¼ inches in exterior, and 1 inch interior diameter. The larger piece was then covered with calico and wound with four copper wires covered with silk, each 23 feet long, and one-eleventh of an inch in diameter—a quantity just sufficient to hide the exterior surface, and to fill the interior opened hole. . . . The above is designated No. 1; and the rest are numbered in the order of their description.

"I made No. 2 of a bar of half-inch round iron 2.7 inches long. It was bent into an almost semicircular shape and then covered with 7 feet of insulated copper wire $\frac{1}{20}$ inch thick. The poles are half an inch asunder, and the wire completely fills the space between them.

"A third electro-magnet was made of a piece of iron 0.7 inch long, 0.37 inch broad and 0.15 inch thick. Its edges were reduced to such an extent that the transverse section was elliptical. It was bent into a semicircular shape, and wound with 19 inches of silked copper wire $\frac{1}{40}$ inch in diameter.

"To procure a still more extensive variety, I constructed what might, from its extreme minuteness, be termed an *elementary electro-magnet*. It is the smallest, I believe, ever made, consisting of a bit of iron wire ¼ inch long and $\frac{1}{16}$ inch in diameter. It was bent into the shape of a semicircle, and was wound with three turns of *uninsulated* copper wire $\frac{1}{40}$ inch in thickness."

With these magnets experiments were made with various strengths of currents, the tractive forces being measured by an arrangement of levers. The results, briefly, are as follows: Electro-magnet No. 1, the iron of which weighed 15 pounds, required a weight of 2,090 pounds to detach the keeper. No. 2, the iron of which weighed 1,057 grains, required 49 pounds to detach its armature. No. 3, the iron of which weighed 65.3 grains, supported a load of 12 pounds, or 1,286 times its own weight. No. 4, the weight of which was only half a grain, carried in one instance 1,417 grains, or 2,834 times its own weight.

"It required much patience to work with an arrangement so minute as this last; and it is probable that I might ultimately have obtained a larger figure than the above, which, however, exhibits a power proportioned to its weight far greater than any on record, and is eleven times that of the celebrated steel magnet which belonged to Sir Isaac Newton.

"It is well known that a steel magnet ought to have a much greater length than breadth or thickness; and Mr. Scoresby has found that, when a large number of straight steel magnets are bundled together, the power of each when separated and examined is greatly deteriorated. All this is easily understood, and finds its cause in the attempt of each part of the system to induce upon the other part a contrary magnetism to its own. Still there is no reason why the principle should in all cases be extended from the steel to the electro-magnet, since in the latter case a great and commanding inductive power is brought into play to sustain what the former has to support by its own unassisted retentive property. All the preceding experiments support this position; and the following table gives proof of the obvious and necessary general consequence: the maximum power of the electro-magnet is directly proportional to its least transverse sectional area. The second column of the table contains the least sectional area in square inches of the entire magnetic circuit. The maximum power in pounds avoirdupois is recorded in the third; and this, reduced to an inch square of sectional area, is given in the fourth column under the title of specific power.

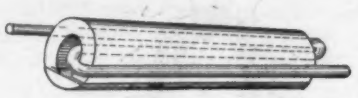


Fig. 8.—Joule's Cylindrical Electro-magnet.

Table 1.

Description.		Least sectional area a.	Maximum power.	Specific power.
My own electromagnets	No. 1	10	2090	209
	No. 2	0.196	49	250
	No. 3	0.0436	12	275
	No. 4	0.0012	0.202	162
Mr. J. C. Nesbit's. Length round the curve, 3 feet; diameter of iron core, 2¾ inches; sectional area, 5·7 inches; do. of armature, 4·5 inches: weight of iron, about 50 pounds		4.5	1428	317
Prof. Henry's. Length round the curve, 20 inches; section, 2 inches square; sharp edges rounded off; weight, 21 pounds		3.94	750	190
Mr. Sturgeon's original. Length round the curve, about 1 foot; diameter of the round bar, ½ inch		0.196	50	255

"The above examples are, I think, sufficient to prove the rule I have advanced. No. 1 was probably not fully saturated; otherwise I have no doubt that its power per square inch would have approached 300. Also the specific power of No. 4 is small, because of the difficulty of making a good experiment with it."

These experiments were followed by some to ascertain the effect of the length of the iron of the magnet, which he considered, at least in those cases where the degree of magnetization is considerably below the point of saturation, to offer a decidedly proportional resistance to magnetization; a view the justice of which is now, after fifty years, amply confirmed.

In November of the same year further experiments* in the same direction were published. A tube of iron, spirally made and welded, was prepared, planed down as in the preceding case, and fitted to a similarly prepared armature. The hollow cylinder thus formed, shown in Fig. 8, was 2 feet in length. Its external diameter was 1.42 inch, its internal being 0.5 inch. The least sectional area was 10¼ square inches. The exciting coil consisted of a single copper rod, covered with tape, bent into a sort of S-shape. This was later replaced by a coil of 21 copper wires, each $\frac{1}{25}$ inch in diameter and 23 feet long, bound together by cotton tape. This magnet, excited by a battery of 16 of Sturgeon's cast-iron cells, each one foot square and one and a half inch in interior width,

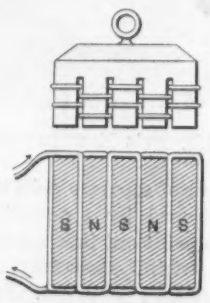


Fig. 9.—Roberts' Electro-magnet.

arranged in a series of four, gave a lifting power of 2,775 pounds.

Joule's work was well worthy of the master from whom he had learned his first lesson in electro-magnetism. He showed his devotion not only by writing descriptions of them for Sturgeon's "Annals," but by exhibiting two of his electro-magnets at the Victoria Gallery of Practical Science, of which Sturgeon was director. Others, stimulated into activity by Joule's example, proposed new forms, among them being two Manchester gentlemen, Mr. Radford and Mr. Richard Roberts, the latter being a well-known engineer and inventor. Mr. Radford's electro-magnet consisted of a flat iron disc, with deep spiral grooves cut in its face, in which were laid the insulated copper wires. The armature consisted of a plain iron disc of similar size. This form is described in Vol. IV. of Sturgeon's "Annals."

Mr. Roberts' form of electro-magnet consisted of a rectangular iron block, having straight parallel grooves cut across its face, as in Fig. 9. This was described in Vol. VI. of Sturgeon's "Annals," page 166. Its face was 6⅝ inches square, and its thickness $2\frac{7}{16}$ inches. It weighed, with the conducting wire, 35 pounds; and the armature, of the same size and 1½ inches thick, weighed 23 pounds. The load sustained by this magnet was no less than 2,950 pounds. Roberts inferred that a magnet if made of equal thickness, but 5 feet square, would sustain 100 tons' weight. Some of Roberts' apparatus is still preserved in the Museum of Peel Park, Manchester.

On page 431 of the same volume of the "Annals" Joule described yet another form of electro-magnet, the form of which resembled in general Fig. 10, but which, in actual fact, was built up of 24 separate flat pieces of iron bolted to a circular brass ring. The armature was a similar structure, but not wound with iron. The iron of the magnet weighed 7 pounds, and that of the armature 4.55 pounds. The weight was 2,710 pounds, when excited by 16 of Sturgeon's cast-iron cells.

In a subsequent paper on the calorific effects of magneto-electricity,* published in 1843, Joule described another form of electro-magnet of horseshoe shape, made from a piece of boiler-plate. This was not intended to give great lifting power, and was used as the field-magnet of a motor. In 1852 another powerful electro-magnet of horseshoe form, somewhat similar to the preceding, was constructed by Joule for experiment. He came to the conclusion† that, owing to magnetic saturation setting in, it was improbable that any force of electric current could give a magnetic attraction greater than 200 pounds per square inch. "That is, the greatest weight which could be lifted by an electro-magnet formed of a bar of iron one inch square, bent into a semi-circular shape, would not exceed 400 pounds."

With the researches of Joule may be said to end the first stage of development. The notion of the magnetic circuit which had thus guided Joule's work did not commend itself at that time to the professors of physical theories; and the practical men, the telegraph engineers, were for the most part content to work by purely empirical

Fig. 10.—Joule's Zigzag Electro-magnet.

methods. Between the practical man and the theoretical man there was, at least on this topic, a great gulf fixed. The theoretical man, arguing as though magnetism consisted in a surface distribution of polarity, and as though the laws of electro-magnets were like those of steel magnets, laid down rules not applicable to the cases which occur in practice, and which hindered rather than helped progress. The practical man, finding no help from theory, threw it on one side as misleading and useless. It is true that a few workers made careful observations and formulated into rules the results of their investigations. Among these, the principal were Ritchie, Robinson, Müller, Dub, Von Kolke and Du Moncel; but their work was little known beyond the pages of the scientific journals wherein their results were described. Some of these results will be examined in my later lectures, but they cannot be discussed in this historical *résumé*, which is accordingly closed.

(To be continued.)

The Dynamo as a Motor.

The easy convertibility of a generator into an efficient motor was demonstrated lately in a very satisfactory manner at the Manningham silk mills of Messrs. Lister & Co., Limited, Bradford. During the recent overhauling of one of the main engines, which worked the machines in the batting, shearing and finishing departments, it was found that repairs had to be made which would take up so much time that, unless substituted power could be obtained, these important departments would be stopped and a number of hands would be idle. As no ordinary or ready means were available for this object, it was suggested by the electrician to the firm, Mr. Edwin Preece, that the dynamo used for the lighting of this department should be tried as a motor in place of the engine under repair. Permission having been granted for this trial, the electrician quickly made the necessary arrangements, and the dynamo was soon at work driving the shafting.

A portion of the mills was lighted by a "Preece" 500-

* "Scientific Papers," vol. i., p. 30.

* "Scientific Papers," p. 40, and "Annals of Electricity," vol. v., p. 170.

* "Scientific Papers," vol. i., p. 123; and "Phil. Mag.," Ser. 3, vol. xxiii., p. 263, 1843.

† "Scientific Papers," vol. i., p. 362; and "Phil. Mag.," Ser. 4, *vol. iii.*, p. 32.

ampère dynamo, driven by an independent Robey engine, while the other portion of the mill was lighted by a similar dynamo, driven by a clutch arrangement from the main engine of the mill, this being the one which was broken down. The two systems of lighting were connected together by mains governed at each switchboard by a double plug switch, with only one pair of plugs, in order to avoid confusion; but, under the altered circumstances, it was necessary to connect up the plug switch at each board, consequently a second pair of plugs had to be obtained; the arrangement was then complete after the ropes from the flywheel had been disconnected from the main driving pulley in the shaft. The Robey engine was started, driving the dynamo attached to it, and generating a current which was transmitted to the second dynamo by means of the conducting wires and the double connection of the switchboards; the second dynamo then became a motor, and, being clutched on to the main shafting by means of its own countershaft, produced sufficient power to work the various machines required in the department.

The whole arrangement was completed in about an hour after the decision had been arrived at, and the machinery was started without the slightest hitch whatever. The current passing into the motor varied from 250 to 500 ampères, according to the different loads, at a potential of 115 volts; it was kept running for about 36 hours without one single stop of the slightest interruption whatever. The remarkable self-regulation and regularity of speed under different loads was an agreeable surprise to the principals of the firm, who were so well satisfied with the new arrangemen s that in all probability a further development of electricity as a motor may be decided upon.

A Montana Electric Light Station.

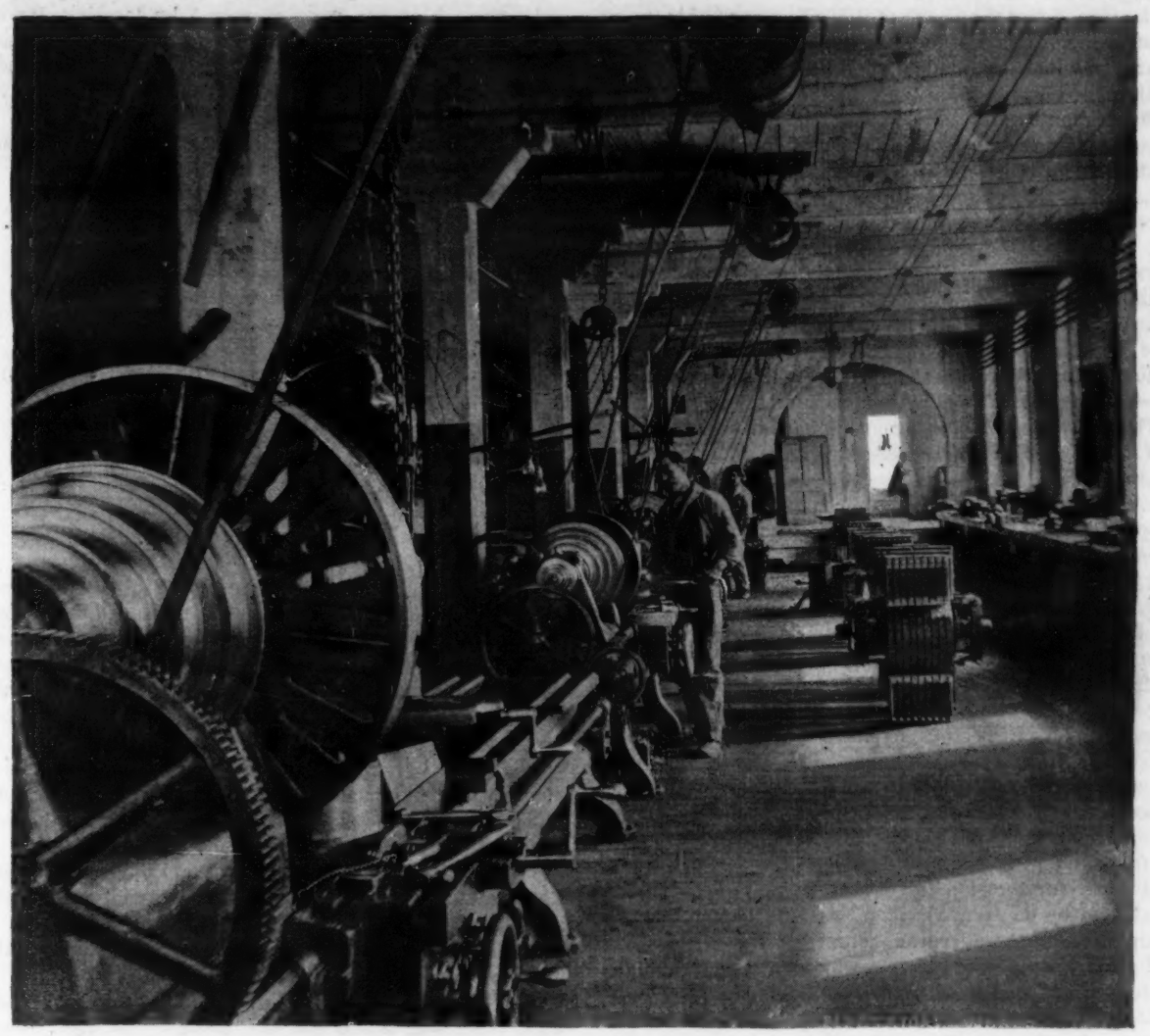
The development of the electric light and power industry in the northwest has been marked by the establishment of some well-built and finely-equipped electric light stations. Our illustration on this page shows an interior view of the station at Livingston, Mont., operated by the Livingston Electric Light Company. The photograph from which our sketch is made was taken by the aid of the arc light, the time of exposure being one minute. A noticeable feature of the view is that, although the plant is in operation, not a single spoke of the engine fly wheels is visible, a fact which shows the speed and smooth running of the engine as well as the perfection of the illumination.

The dynamos, as will be seen, are of the Thomson-Houston type, one being a 650-light alternator and the other a 20-light arc machine. The dynamos are driven by a compound condensing McIntosh & Seymour engine, and this is connected to the dynamos by the best quality of Shultz belts. The engine, as will be seen, is placed upon a brick foundation. The dynamo room is neat and well kept, and there is a noticeable absence of unsightly wires in all parts of the room and especially upon the face of the switchboard. At the top of the switchboard are seen the lightning arresters, which are of the well known Thomson-Houston type. The measuring instruments and resistance box are shown on the lower part of the switch-board. The plant is operated under the supervision of Mr. F. H. Ross, and the general neat and orderly appearance of the station does him great credit.

ELECTRIC LIGHT PLANT AT LIVINGSTON, MONT.

An Electric Motor Factory.

The rapid development of electric railroading in this country has given rise to some very large and important factories entirely devoted to the construction of electric motors for this purpose. In the accompanying illustration is shown one section of the assembling room of the United Electric Traction Company's factory at Jersey City, N. J., in which the motors of this company's system of electric traction receive the finishing touches before they are sent out for actual service. At the right of the illustration are seen some of the frames of the 30 h. p. railway motors of the type now employed on the cars of this company in various parts of the country. It will be seen that these frames are for motors of the old Siemens' two-pole type, with four coils, the cores being built up of bars of soft wrought iron. With the exception of that shown in our illustration, the entire machinery of this factory is operated by electric power, thus avoiding the use of a very large amount of unnecessary counter-shafting. In the assembling room, however, the machines used for heavy work are driven directly from the factory engines. The factory is lighted by both arc and incandescent lamps.



ASSEMBLING ROOM IN A MOTOR FACTORY.

The Electrical Tramway in Paris.

Experiments with the working of tramways by electricity, says the London *Electrician*, are being continued in Paris by the Northern Company on the line between Levallois and Madeleine. Four cars are practically worked, and the Société Française d'Accumulateurs Electriques (Faure-Sellon-Volckmar), who supply the motive power at the rate of 3d. per car and kilometre, are of opinion that the traffic will be permanent. The motive power is furnished by Faure-Sellon-Volckmar accumulators, with double plates. The batteries are divided in 12 boxes, each containing nine elements coupled in series, 108 cells in all, and as each element weighs 15 kilograms, the total weight of the battery is 1,620 kilograms.

The 12 boxes are placed in cupboards in the corners of the car—four in front and eight behind. The connections are so arranged that the elements, when the boxes are fixed in their places, become automatically ranged in groups of three by three boxes behind each other, so that there are four groups in all of 27 elements ranged after each other. These four groups may be connected for work in four different ways, as at the Birmingham tramway. The various connections are effected by the aid of a commutator, consisting of a wooden cylinder, with contacts on the surface. The cylinder is turned by a handle. The electrical motor is of Siemens' construction, and situated below the car in front. The number of revolutions may be raised to 1,600 a minute, but under normal working it is 1,000. The power is transmitted to the wheels of the car through gearing, which reduces the speed in the proportion of 26 to 1.

The motor is reversed by the use of a double set of brushes. The cars weigh 3,500 kilograms, there being 1,600 kilograms of accumulators, and they carry 50 persons. During ordinary speed of 11 kilometres (6.85 miles) an hour the electrical work required is as follows: On level road, 4.3 h. p. (16 ampères × 200 volts); on incline of 1 in 100, 7.8 h. p. (29 ampères × 200 volts; on incline of 1 in 50, 11 h. p. (42 ampères × 200 volts). With a speed of 9 kilometres (5⅝ miles) an hour and an incline of 1 in 33, 12.3 h. p. (46 ampères × 200 volts) are required. On an incline of 1 in 25, 15.3 h. p. (57 amp res × 200 volts). Finally, with a speed of 5 kilometers (3 miles) an hour and an incline of 1 in 20 the force is 10.2 h p. (38 ampères × 200 volts), and on an incline of 1 in 18, 10.75 h. p. (40 ampères × 200 volts).

Behavior of Lubricating Oils.*

Experiments to determine the coefficient of friction between lubricated rubbing surfaces have been prosecuted for 200 years and have resulted in the construction of many forms of satisfactory apparatus for such measurement, which are now known as oil testing machines. Such machines are now being resorted to by large consumers of oil as a means of discriminating between the lubricating value of the numerous oils offered by manufacturers,

* Synopsis of a paper read at the Indianapolis meeting of the American Association for the Advancement of Science, by J. E. Denton, of Hoboken, N. J.

and which, while practically alike in fluidity and general oily qualities, are nevertheless claimed to differ in their respective abilities to afford satisfactory lubrication.

The only difference of behavior of all these lubricating oils shown by the oil testing machines, is simply such differences of frictional resistance as can be ascribed to the variation in viscosity of the substances in the fluid condition, and this difference of friction fails to account for the well-attested fact that some of the oils are unable to prevent excessive heating and cutting on heavy machinery bearings, which exhibit no such action when lubricated with other oils.

Experiments were described which have been made with a special apparatus constructed for the lubricating committee of the Standard Oil Company, proving that the overheating of bearings is due to accidental abrasion of the rubbing surfaces, caused by the gradual and inevitable variations of the smoothness of these surfaces by metallic wear. This abrasion generates a comparatively intense heat at some point of the bearings, and tends to vaporize some oils more than others. Oils which are incapable of resisting excessive vaporization by such accidental heating are those which permit bearings to more frequently overheat than do others not so affected by temperature.

The prevailing oil testing machines fail to reveal such differences in oils: (1) because they have invariably been operated with artificially smooth surfaces: (2) because whenever accidental abrasion takes place observations are suspended until the heating tendency due to abrasion has been eliminated, and (3) because the oil supply to the testing journals is artificially abundant. instead of being restricted by feeding through practical forms of oil cups. By this means accidental deficiencies of supply which are frequently the initial cause of abrasion and overheating are eliminated and differences among oils depending on their ability to feed more or less uniformly by virtue of capillary action cannot be noted. It is therefore concluded that in order to enable mechanical oil tests to reveal the actual differences of lubricating value among current lubricants, each oil must be tested with a series of conditions of the rubbing surfaces and practical feeding devices which involve opportunities for abrasion and overheating. The lecture was illustrated by lantern views of various new devices for testing lubricants under the actual conditions of service, and also by samples of bearings which have been in service under various conditions, representing unsatisfactory lubrication. Explanations were offered of the paradoxical fact that overheating is often relieved by supplying sand or emery to bearings.

Some Long-Lived Incandescent Lamps.

Below is the remarkable record of a group of six 52-volt 16 c. p. lamps exhausted on the Berrenberg vacuum pump, now the property of the Beacon Vacuum Pump and Electrical Company, of Boston.

These lamps were burned three volts over normal pressure, with the following results: 1st, 888 hours; 2d, 960 hours; 3d, 1,182 hours; 4th, 1,564 hours; 5th, 1,704 hours; 6th, 2,753 hours. This speaks well for the results obtained by the Berrenberg pump, as, without the most perfect vacuum, lamps cannot attain such length of life, especially when burned over their normal voltage.

To still further illustrate the beneficial effects of a non-mercurial vacuum on incandescent lamps, it may be noted that two lamps of 52 volts 16 c. p. each, exhausted on the Berrenberg pump, were burned on 110-volt circuit, each lamp taking the whole voltage. The lamps developed 750 c. p. each. One of them burned in this way for 45 minutes, and the other for 1¼ hours before burning out. Lamps with ordinary mercurial vacuums under this test, burned out at once.

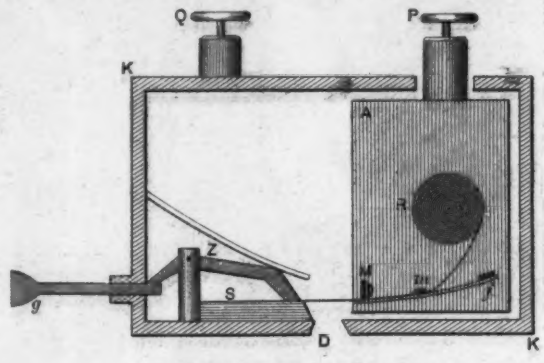
The Siemens-Violle Standard Lamp.*

BY DR. E. LIEBENTHAL.

The forms up to the present suggested for obtaining the unit of light passed by the Paris Congress have all of them many inconveniences, being both difficult to manage and most of them costly. That illustrated in the accompanying figure has been specially designed to overcome these difficulties. A stand some four inches high carries a box *K K*, shown nearly full size in the cut. On the bottom of the box is an insulated metal plate *A*, on which is a small drum of platinum strip *R*, a movable half cylinder *m*, a larger fixed one *M*, and a terminal *P*. The strip passes under *M* and *m*, against which it is pressed by the spring *f*, and thence to the plate *S*, where it is clamped by the claw *Z*. The strip is now stretched by turning *m* backwards, and on passing a current through the instrument the platinum is melted, the light being observed through the aperture *D*. The handle *g* is now pressed, pushing *S* and *Z* forward, and at the same time lifting *Z*. On pulling *g* back, *Z* falls again, clipping the end of the platinum, and drawing on a fresh piece for the next reading.

The lamp does not absolutely fulfill the requirements of the Congress, as the source of light is platinum just melted, instead of melted platinum on the point of solidification; but, if it should be found necessary, a correction factor may be ascertained once for all. The cost is infinitesimal compared to that of the original standard, one gram of platinum, costing about 67 cents, being sufficient for 50 readings. The metal is also obtained pure without difficulty, as there is, of course, no fouling due to the source of heat.

Preliminary trials with the lamp showed several small defects in the means of making contact on the right-hand side; these, however, were overcome by covering *M* with platinum, and abolishing *m* altogether, the strip being tightened by manipulating *g*. It was found also that more or less tension had but very slight effect on the results obtained. The current used varied from 9 ampères to as much as 18, due to variation in the gauge of platinum



A New Standard Lamp.

supplied. The strip used was about 5.5 millimetres broad and .011 millimetres (.00044 inch) thick. A very large number of comparisons were made against the amyl-acetate standard, the current being slowly augmented, and the grease-pot carrier slid along the photometer bar as the light increased, the point at which the carrier stood when the coil fused being taken as the reading. The results obtained do not agree perfectly among themselves, the mean error in 180 readings being 2.9 per cent., whereas the same observer made two amyl-acetate lamps agree within 0.95 per cent. The errors are attributed both to variation of the platinum standard itself, and also to the fact that just before melting the light is considerably whiter than the amyl standard.

As the final result Dr. Liebenthal gives the value of the amyl-acetate standard as .569 Congress unit.

Herr v. Siemens originally gave the figure as 0.7 legal unit, but thought that this was probably too high, owing to impurities in the platinum.

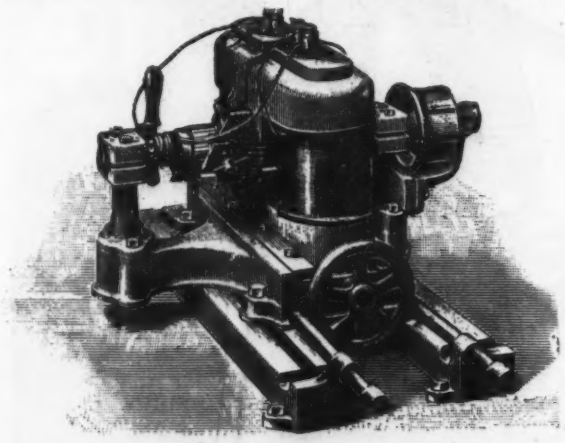
From previous experiments the value of the English standard candle has been found to be 1.169 that of the amyl-acetate lamp, which makes the legal value of the candle .665 legal unit. On the other hand, Herr Violle himself has made the value .54, a difference of over 20 per cent.

In conclusion Dr. Liebenthal says that owing to the color the platinum lamp is best suited for arc-light determinations, and recommends that the platinum should only be about .2 to .3 mils. thick.

*From *The Electrician*, London. Abstracted from the *Elektrotechnische Zeitschrift*.

A New English Dynamo.

The accompanying illustration shows a rather neat dynamo, recently brought out in England, especially for arc lighting in small installations. It is interesting to observe that it embodies a modification of the Diehl motor method



Dynamo for Small Plants.

of regulation, as its electromotive force is varied by moving the field magnets away from the armature. It is a machine of the Manchester pattern, but with two really independent magnetic circuits, inasmuch as the two parts of the magnets can be moved apart by the regulating wheel shown in the figure. This arrangement permits of changing the electromotive force within a very wide range, so that the dynamo can be used for almost any kind of service. It is made, if desired, self-regulating, but in the ordinary patterns the magnets are moved by hand to give any strength of field, and consequently the electromotive force that may seem necessary. For small installations where a few arc lamps are in circuit, and the machine must occasionally be used for other purposes, the arrangement is specially convenient, although there is nothing strikingly original about it. In operating arc lamps the magnets are simply screwed apart until the voltmeter shows the necessary pressure for the number of lamps then in circuit. If incandescent lamps are to be used with it, the regulator will serve the purpose of cutting down the electromotive force to any desired point; so that, for example, in a theatre, where it is necessary to turn the lights up and down, they can be graded to any degree of brightness. It will be noticed that the machine is provided with three bearings for the sake of steadiness, and is simply and strongly built. It should possess some merits for use in an experimental way where a large range of voltage is particularly desirable.

Electrical Distribution by Transformers from Central and Eccentric Stations.*

BY DR. J. A. FLEMING, M. A.

§ 10. *Transformers at Milan.*—Although the central station at Milan was designed originally on the lines of an Edison direct-current low-pressure station, it has been found essential to supplement the direct-current plant by an alternating transformer system to reach the outlying districts of the city. There are at the present time (1890) two combined engines and alternators by Ganz in the Milan central station, which machines are generally similar in arrangement although slightly different in details to the steam dynamos at Leghorn. These alternators are of the 80 kilowatt size, driven direct by high-pressure engines at a speed of 250 revolutions, and generating a 40-ampère primary current at 2,000 volts pressure. There are no separate exciters, but the alternators take exciting current to the amount of 28 amperes or so at 110 volts from the Edison low-pressure mains. These machines, of which one is a reserve on the other, feed with the usual Ganz regulating arrangements into one single underground conductor of the Siemens concentric pattern, which runs from the station in the Via St. Radegonda to the Dalverme and Fossati theatres, about one and a quarter miles, or 1,800 metres, from the station. In the Dalverme Theatre there is a bank of 11 transformers of the 7.5 kilowatt size, and in the Fossati Theatre two such transformers; these transformers feed between them about 1,800 incandescent lamps of 16 c. p., 8 c. p. and 10 c. p. The cable carrying the primary current has a cross sectional area of 28 square millimetres in each member. The insulation, after three years of working, is very high and is between 3,000 and 5,000 megohms per kilometre.

The transformers are of the latest pattern, as described in foregoing sections, and the arrangement for maintaining a constant potential at the supply end of the main is similar to that employed at Rome. The plant has been in perfectly satisfactory operation for three years, and will, no doubt, in time be greatly extended.

§ 11. *Other Transformer Stations by Ganz.*—The distribution of electrical energy by alternating current transformers is making very considerable progress in Italy, under the system of Zipernowsky, Déri and Bláthy. The list on the next page gives the locality and approximate output (in 1890) of these stations in Italy. From this table it will be seen that at the date of writing (1890) the output of all the stations taken together which work an alternating system is about 4,000 h. p., or some 3,220 kilowatts, and will in the immediate future be very greatly extended in consequence of the advantages offered by this system in utilizing water power. Already, as is well known, a very large alternating plant is being arranged at Tivoli, near Rome, which is to be operated by water power, and to furnish current for lighting purposes in the city of Rome.

At Marienbad there is a transformer station also operated by a similar plant, which was inaugurated in May, 1889. Street lighting is done by 36 alternate-current arc lamps and by incandescence lamps, and about 1,800 glow lamps of 16 c. p. are employed at private houses worked off a transformer system. The station is situated about a mile and a quarter from the centre of the town, and is a brick building, having an area of 600 square yards, and divided into a boiler house and engine room. The dynamos are Ganz alternators of 50,000 watts output each. Four such dynamos are driven direct by Westinghouse engines made by Alley & Maclellan, in Glasgow. The exciters are driven by belts off the alternators. The alternators generate current at a pressure of 2,000 volts. The primary and secondary conductors are carried overhead on posts separated by about 35 yards, and the transformers are contained in weather-tight receptacles on posts also. Three alternators are usually coupled together in parallel during the heavy time of load, and one machine held as a reserve. The dynamos work perfectly well in parallel, and are put on or off the circuits by the same arrangements as those described for the Leghorn central station.

There is a small water-power transformer station at Valreas and Dieulefit, which is interesting as an example of transmission of power. Valreas (Vaucluse) and Dieulefit (Drôme) are electrically lit by means of power taken from a fall of water at Béconne, three miles from Dieulefit and nine miles from Valreas. At Béconne there are a couple of horizontal turbines, which yield each about 50 h. p. at 180 turns per minute. Each turbine drives a Ganz alternator of 24 kilowatts output and an exciter of three kilo-

* Continued from The Electrical World, Aug. 30, 1890.

watts output. The regulation of the turbines is effected by a hydraulic regulator by Bouvier, and the regulation of the primary electromotive force at the consumption end of the line is effected by the use of a mercury cup rheostat as before described.

The primary current is conveyed by a bare overhead silicon bronze wire, of 3.2 millimetres diameter (No. 10, B. W. G.) and a resistance of 11.8 ohms, to Dieulefit, and to Valreas by a similar wire of 6.6 millimetres in diameter (No. 3, B. W. G.) and 16.1 ohms resistance. The wires are carried on double shed porcelain insulators. The transformers are held in iron cases carried on posts, and from them are distributed insulated secondary wires to the houses. The station, although very small, offers an interesting example of the conveyance and utilization of water power by transformer plant.

In Paris, the Continental Edison Company carry out the lighting of the Palais de l'Elysée from their station situated about one mile and a quarter away by means of Ganz alternators and transformers. Two alternators of 90 kilowatts and two of 24 kilowatts furnish current for 1,800 glow lamps in the palace. The primary current is conveyed at a pressure of 2,000 volts by an underground concentric cable. The pressure is kept constant at the far end by the usual regulation of the exciting current, which is taken off from the direct-current machines in the same station. The four machines can be worked in parallel on to the single main, and the switchboard is arranged to permit this to be done.

LOCALITY AND APPROXIMATE OUTPUT OF CENTRAL STATIONS IN ITALY.

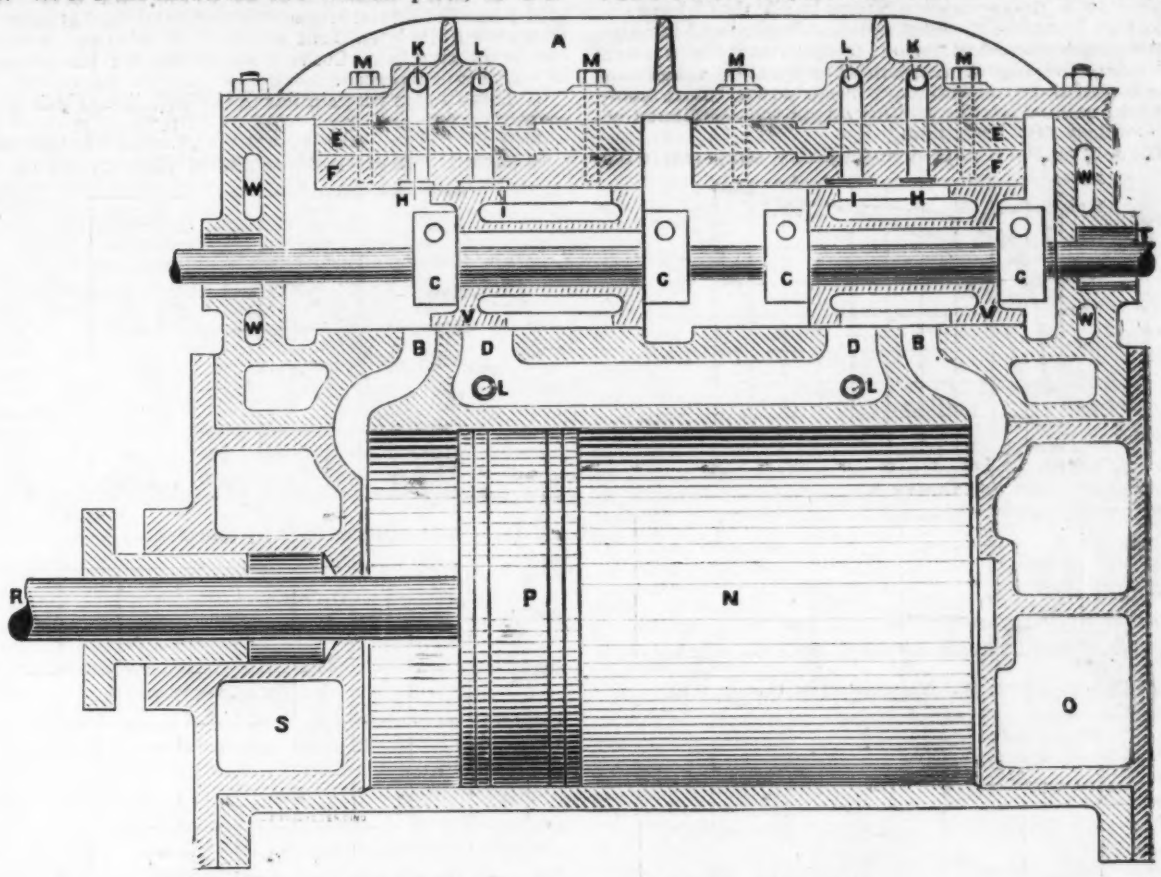
Station.	Motive power.	Full capacity in kilowatts.
Alanzo	Water	100
Bagni	"	15
Bassano	"	50
Cuneo	"	150
Palermo	"	40
Perdehohe	"	30
Terni	"	240
Trevisa	"	60
Taglicozzo	"	15
Leghorn	Steam	240
Milan	"	150
Rome	"	1,440
Syracuse	"	150
Turin	"	300
Venice	"	160

(To be continued.)

A New Balanced Valve for Steam Engines.

The accompanying illustrations give a very clear idea of the construction and operation of a new balanced steam engine valve, the invention of Mr. F. I. Freeman, general manager of the Ætna Machine Company, Warren, O., and which has been lately patented by him.

The figure represents a horizontal section through the centre of the cylinder, valves and steam chests. Referring to the parts as shown in the figure, *A* represents the steam chest lid or cover; *B B* are the two steam ports for admitting the steam into the cylinder, and *C C C C* are the four clamps on the valve rod that hold the valve in position. At *D D* are shown the two exhaust ports; at *E E* the two wedge plates between the outer valve seat and the steam chest cover for adjusting the two outer valve seats: at *F F* the two outer valve seats; at *H H* two false steam ports in the outer valve seats directly opposite the steam ports in the cylinder, and at *I I* are shown the two false exhaust ports in outer valve seats directly opposite the exhaust ports in the cylinder. At *K K* are the ends of the pipe that carry live or compressed steam from the cylinder into false ports in the outer valve seats; *L L* show the ends of pipe that carry exhaust steam from the exhaust cavity of the cylinder into the false exhaust ports in the outer valve seats; *M M M M* are the cap screws for holding the outer valve seats and the wedge plates in position after the valve has been adjusted; *V V* are the valves, and at *W W W W* is shown the cavity for live steam in the outer walls of the steam chest. This cavity entirely surrounds the steam chest.



BALANCED VALVE FOR STEAM ENGINES.

The outer valve seats are secured against end motion by tongue and cavities in the steam chest cover, adjusting wedges and false seats, as is clearly shown in the figure. The false seats are also held firmly in position by four cap screws in each seat. These cap screws pass from the outside of the steam chest cover through the adjusting wedge plates and are secured into the outer valve seats. The holes in the adjusting wedge plates are slotted where the cap screws go through in order to allow them to be moved up or down to adjust the outer valve seat.

In order to adjust the valves, all that it is necessary to do is first to set the valves in the ordinary way. The wedges and the outer valve seats are then placed on the steam chest lid or cover and the lid then put in position. The outer valve seat is then adjusted by means of the adjusting plate being raised or lowered by the adjusting screw *X* until the valve moves freely between the two valve seats, just tight enough so that the steam cannot pass between the faces of the valves and seats. The wedges and seats are then secured to the steam chest lid or cover by means of the cap screw *M*.

The valves are then adjusted, and as there can no steam come in contact with the back of the valve, the valve must be balanced except when the steam port is covered. When the steam port is entirely covered by the valves, there is a pressure nearly equal to boiler pressure on the under side of the valves, for the reason that at this time compression begins to take place, and if it were not overcome there would be a pressure against the under side of the valve and the face of the outer valve seat.

To overcome this, the steam that is confined in the cylinder is carried through the pipe *K* into the false steam port *H*, in the outer valve seat. Therefore any pressure on the under side of the valve through the steam ports also occurs on the back of the valve in the false steam ports in the outer valve seats. This gives exactly the same pressure on the outer side of the valve as on the under side. Any pressure from exhaust steam is counteracted in the same way by means of the pipe *L*.

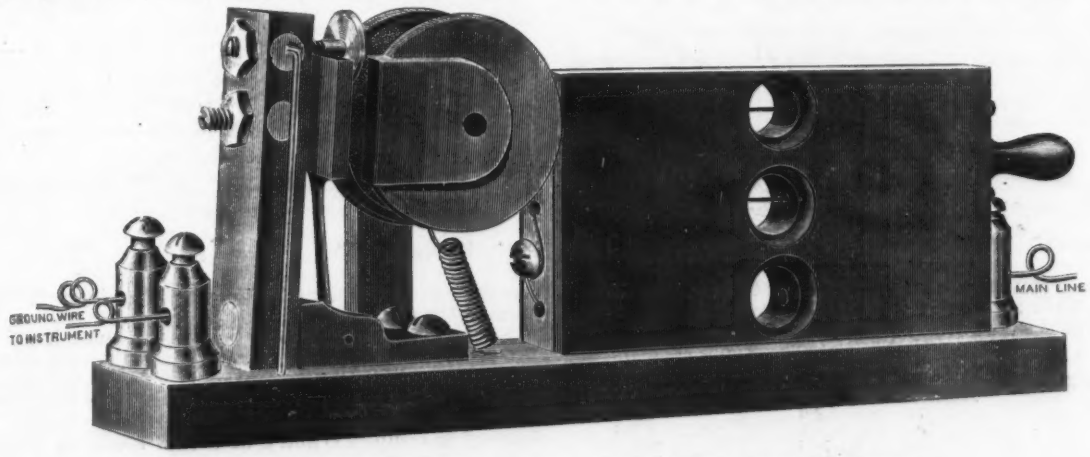
It will be noticed that the valves are simply frames; that is, the lips on the top and bottom of the valves are exactly the same width; consequently the exhaust cavity in the valve is not covered as in the ordinary slide valve, so that when the steam is exhausting, the exhaust steam, instead of creating a pressure on the under side of the valve, passes clear through the valve, and the pressure is exerted on the outer valve seats.

In cold weather, the metal in the valves being thinner than that in either the steam chest cover or steam chest, the valves might perhaps, when the engine is first started in the morning, expand a little sooner than the steam chest, owing to their being entirely surrounded by steam, and cause the valves to stick, perhaps tight enough to cut, until every part of the steam chest and cover is thoroughly warmed up. To prevent this the steam chest is cast with a cavity in the outer walls. This cavity, *W W W W*, entirely surrounds the steam chest. Live steam is taken from the steam pipe above the engine throttle valve and carried into this cavity. This steam expands the outer walls of the steam chest, so that the valves are free and would possibly leak a little instead of binding for the first few revolutions, or until the steam chest and lid are thoroughly warmed up and expanded. This prevents the danger of sticking, for the moment there is any steam in the boiler there is also steam in the steam pipe and in the cavity around the steam chest and the steam chest quickly becomes expanded so that the engine is always ready to start without danger.

Rich's Double Pole Protector and Cut Out.

The double pole protector and cut out, illustrated on this page, embodies many of the essential features of a successful protector, and is intended for use on telephone lines to prevent damage from abnormal currents.

The operation of this protector is as follows: The current enters at the main line binding post, passes through one of the fuse wires in the fuse magazine, through the magnet coil to the armature on the magnet stand, and then to the contact post leading to the telephone instrument. In case of a heavy current coming over the line, the double pole magnet is energized, attracting the armature and breaking the circuit to the telephone, and at the same instant establishing a circuit to the ground through the grounded line of the protector. As soon as the heavy current is removed the armature automatically re-establishes the circuit to the telephone instrument. In case of an excessive current the fuse in the fuse magazine instantly blows out, thus cutting both the telephone and protector completely out of circuit and shutting the current out of the building. The openings in the fuse magazine afford an opportunity of ascertaining when the fuse wire is melted, and also prevent any excessive currents from arcing across and burning out the protector at the time the fuse wire blows out.



DOUBLE POLE PROTECTOR FOR TELEPHONE INSTRUMENTS.

These protectors are manufactured by the Electric Protector and Specialty Company, of Cincinnati, O., under the supervision of Mr. H. G. Rich, the superintendent, and the inventor of the protector. He claims that the double pole feature of the magnet is an important one where there is a liability of having to contend with "sneak" currents. The fuse magazine is a useful feature, as it enables the telephone subscriber to re-establish the circuit in case the fuse should be blown out.

Alloys for Fuses.

The following proportions for fusible alloys may be of interest to those of our readers who have occasion to make or use fuses. It will be seen that they are due to Weisbach and have been used in actual practice. The range of melting point is so great that almost any desired current can be probably taken care of without the use of too small a wire.

Lead.	Tin.	Bismuth.	Melting points in degrees Centigrade.
1	1	4	92.8
5	3	8	94.4
2	3	5	94.4
1	4	5	112.8
1	4	1	125
1	1	1	141.1
1	2	1	167.7
1	3	1	167.7
1	3	1	200

Magnetic Properties of Alloys of Nickel and Iron.*

BY J. HOPKINSON, D.SC., F.R.S.

Eight different alloys have been examined, distinguished here by the letters of the alphabet. All the samples were given to me by Mr. Riley, of the Steel Company of Scotland, who also furnished me with the analysis given with the account of the experiments with each sample.

The methods of experiment were the same as were detailed in my paper on "Magnetic and other Physical Properties of Iron at a High Temperature." The dimensions of the samples were also the same. For this reason it is unnecessary to recapitulate the methods adopted. I confine myself to a statement of the several results, dealing with each sample in succession.

A. The following is the analysis of this sample:

Fe.	Ni.	C.	Mn.	S.	P.
97.90	0.97	0 42	0.58	0.03	0.04 per cent.

In this case a magnetization curve is all that I have obtained free from doubt; the sample was heated and its magnetization determined at various temperatures for a force of 0.50, but the higher temperatures must be taken as a shade doubtful, as the secondary broke down before cooling, and I cannot be sure whether or not the resistance of the secondary may have changed.

Table I. gives the results at the ordinary temperature for the material before heating; these are plotted in Curve 1, together with the curve for wrought iron, for comparison:

TABLE I.

Magnetizing force.	Induction.	Magnetizing force.	Induction.
0.06	11	4.7	4,560
0.12	29	8.8	9,151
0.25	58	16.8	12,876
0.52	122	38.9	15,651
1.07	303	270.0	21,645
2.14	905		

The only noteworthy features are that the coercive force is obviously somewhat considerable, and that the maximum induction is great—greater than that of the more nearly pure iron.

In Curve 2 are shown the results of induction in terms of the temperature for a force of 0.50.

B. The following is the analysis of the sample:

Fe.	Ni.	C.	Mn.	S.	P.	Si.
93.4799	4.7	0.22	0.23	0.014	0.037	trace per cent.

We have here results of induction in terms of temperature for a magnetizing force of 0.12, shown in Curve 3, and for comparison therewith the results of rate of heating and cooling in Curves 4 and 5 respectively. The experiment with rising temperature was made by simply observing with a watch the hour at which the temperature attained successive values whilst the piece was in the furnace; the cooling experiments were made in exactly the way described in "Phil. Trans.," A, 1889, p. 433; in the experiment with rising temperature, however (Curve 4), the ordinates are the actual temperatures, not the logarithms of the excess of temperature above the room, as in Curve 5. The most remarkable feature in Curve 3 is that the material has two critical temperatures, one at which it ceases to be magnetizable with increase of temperature, the other, and lower, at which it again becomes magnetizable as the temperatures fall, and that these temperatures differ by about 150 degrees C. Between these temperatures, then, the material can exist in either of two states—a magnetizable and a non-magnetizable. Note, further, that the curve for decreasing temperature returns into that for increasing temperature, and does not attain to the high value reached when the temperature is increasing. From Curve 4 we see that there is absorption of heat about 750 degrees C., and not before; and from Curve 5 that heat is given off at 632 degrees C., and again at a lower temperature. Comparing these temperatures with Curve 3, it is apparent that the absorption and liberation of heat occur at the same temperature as the loss and return of the capacity for magnetism. From Curve 5 also we may infer that the latent heat liberated in cooling is about 150 times the heat liberated when the temperature of the material falls 1 degree C. Concerning the latent heat absorbed in heating, nothing can be inferred from Curve 4, excepting the temperature at which it is absorbed.

C. This alloy is very similar to the last; its analysis is:

Fe.	Ni.	C.	Mn.	S.	P.
94.39	4.7	0.27	0 57	0.03	0.94 per cent.

In Table II. are given the results of observations of induction in terms of magnetizing force at the ordinary temperature of the room; and in Curve 6 these are plotted together with the curve for wrought iron.

TABLE II.

Magnetizing force.	Induction.	Magnetizing force.	Induction.
0.06	14	4.6	3,068
0.12	29	8.7	8,786
0.25	61	16.6	13,641
0.52	127	38.5	16,702
1.05	294	266.5	21,697
2.10	760		

The material appears to be capable of considerably higher magnetization than wrought iron. In Curve 7 is shown the relation of induction and temperature for two forces, 26.5 and 0.5, the results being obtained on two different days, to the same scale of abscissæ but different scales of ordinates. These curves show the same features as the alloy B, but at a rather lower temperature.

D. This sample contains 22 per cent. of nickel. It was not thoroughly tested, as the supply of CO_2 which happened to be available was insufficient. Its magnetic properties, however, were similar to the next sample.

E. The analysis of this sample * was:

Fe.	Ni.	C.	Mn.	S.	P.	Si.
74.31	24.5	0.27	0.85	0.01	0.04	0.02 per cent.

As the material was given to me it was non-magnetizable at ordinary temperature; that is to say, the permeability was small, about 1.4, and the induction was precisely proportional to the magnetizing force. The ring on being heated remained non-magnetizable up to 700 degrees C. or 800 degrees C. A block of the material did not recalesce on being heated to a high temperature and being allowed to cool.

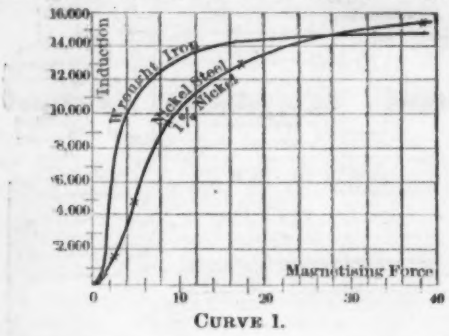
On being placed in a freezing mixture, the material became magnetic at a temperature a little below freezing point.

The material was next cooled to a temperature of about —51 degrees C. by means of solid carbonic acid. After the temperature had returned to 13 degrees C. the curve of magnetization was ascertained as shown in Curve 8; from this it will be seen that the ring of the material which was previously non-magnetizable at 13 degrees C. is now decidedly magnetizable at the same temperature. On heating the material, it remained magnetizable until it reached a temperature of 580 degrees C. At this temperature it became non-magnetizable, and, on cooling, remained non-magnetizable at the ordinary temperature of the room. Curve 9 shows the induction at various temperatures for a magnetizing force 6.7; while Curve 10 shows the induction in terms of the temperature to a different scale for a force of 64. These curves show that, through a range of temperature from somewhat below freezing to 580 degree C., this material exists in two states, either being quite stable, the one being non-magnetizable, the other magnetizable. It changes from non-magnetizable to magnetizable if the temperature be reduced a little below freeezing; the magnetizable state of the material does not change from magnetizable to non-magnetizable until the temperature is raised to 580 degrees C.

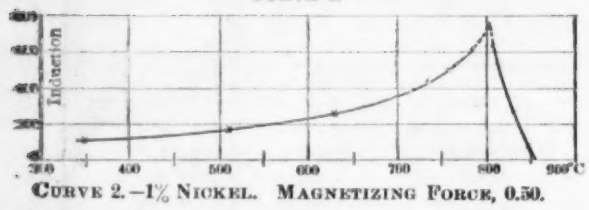
The same kind of thing can be seen in a much less degree with ordinary steel. Over a small range this can exist in two states; but in changing its state from non-magnetizable to magnetizable a considerable amount of heat is liberated, which causes rise of temperature in the steel. It is observed in samples B and C of nickel steel, as we have just seen, but at a higher temperature.

As might be expected, the other physical properties of this material change with its magnetic properties. Mr. Riley has kindly supplied me with wire.

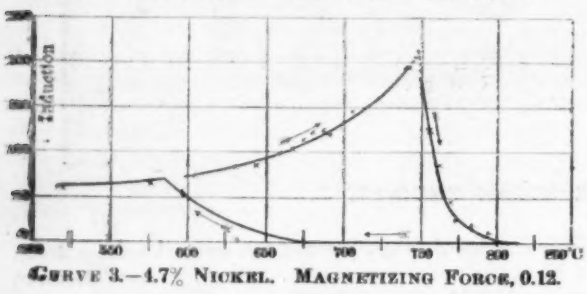
The wire as sent to me was magnetizable as tested by means of a magnet in the ordinary way. On heating it to a dull redness it became non-magnetizable, whether it was cooled slowly or exceedingly rapidly by plunging it into cold water. A quantity of the wire was brought into the non-magnetizable state by heating it and allowing it to cool. The electric resistance of a portion of this wire, about five metres in length, was ascertained in terms of the temperature; it was first of all tried at the ordinary temperature, and then at temperatures up to 340 degrees C. The specific resistances at these temperatures are indicated in Curve 11 by the numbers 1, 2, 3. The wire was then cooled by means of solid carbonic acid. The supposed course of change of resistance is indicated by the dotted line on the curve: the actual observations of resistance, however, are indicated by the crosses in the neighborhood of the letter A on the curve. The wire was then allowed to return to the temperature of the room, and was subsequently heated, the actual observations being shown by crosses on the lower branches of the curve; the heating was continued to a temperature of 680 degrees C., and the metal was then allowed to cool, the actual observations being still shown by crosses. From this curve it will be



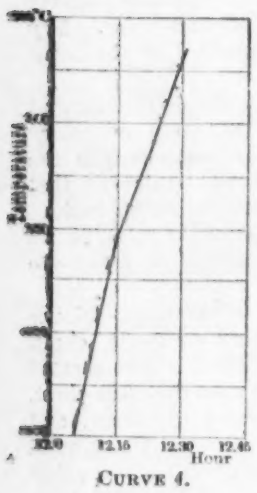
Curve 1.



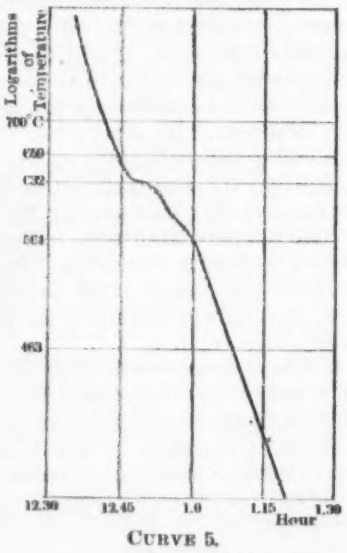
Curve 2.—1% Nickel. Magnetizing Force, 0.50.



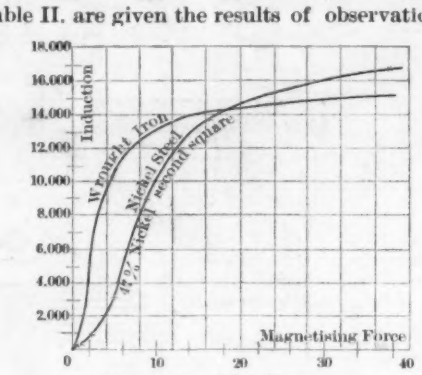
Curve 3.—4.7% Nickel. Magnetizing Force, 0.12.



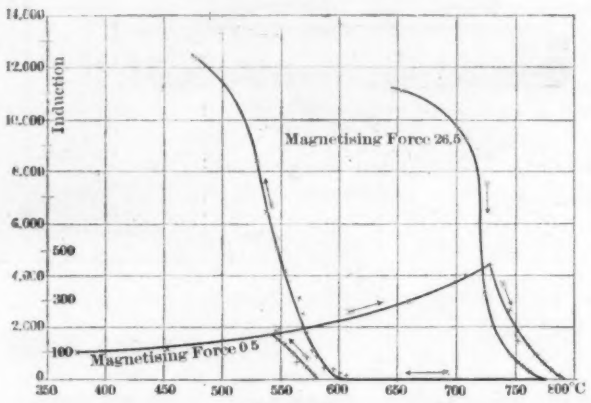
Curve 4.



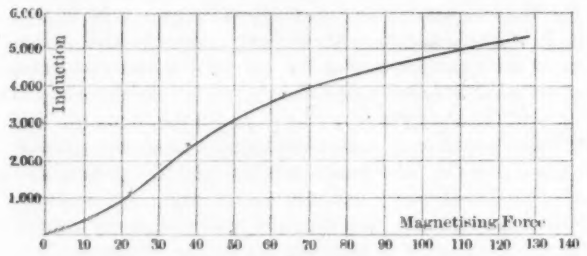
Curve 5.



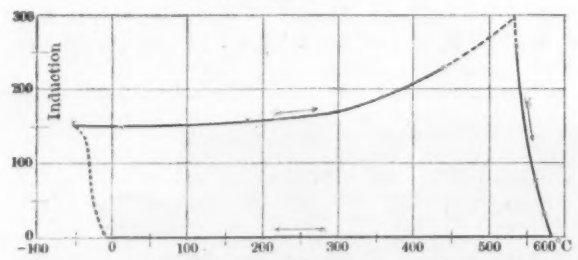
Curve 6.—4.7% Nickel.



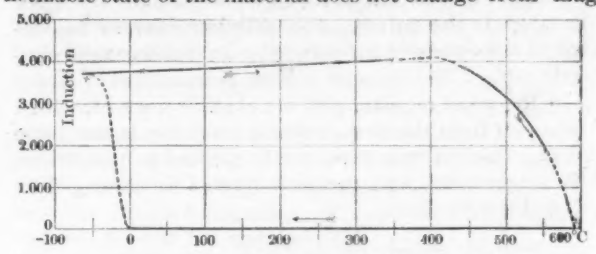
Curve 7.



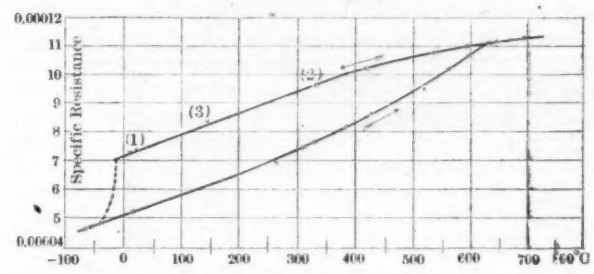
Curve 8.—25% Nickel.



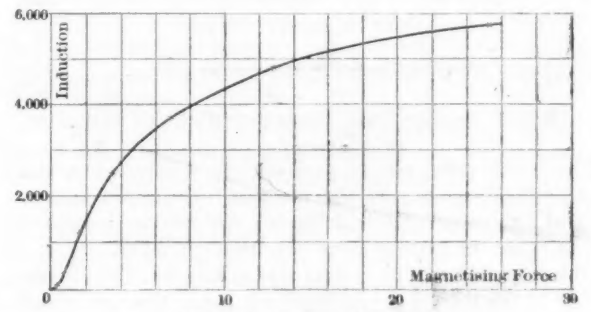
Curve 9.—25% Nickel. Magnetizing Force, 6.7.



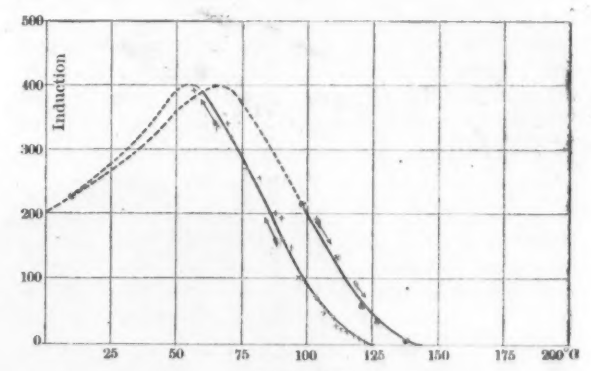
Curve 10.—Magnetizing Force, 64.



Curve 11.



Curve. 12—30% Nickel.



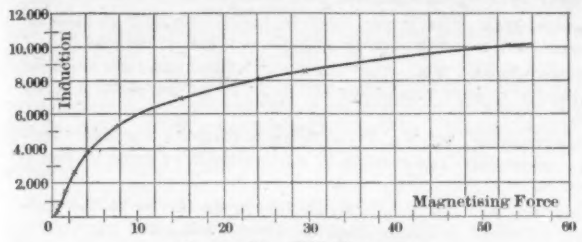
Curve 13.

CURVES 1 TO 13.—MAGNETIC PROPERTIES OF ALLOYS OF NICKEL AND IRON.

*From the Proceedings of the Royal Society, Vol. 48.

* The results with this sample have already been presented to the Royal Society ("Proceedings," Vol. 47, pp. 23 and 188), but are repeated now for completeness.

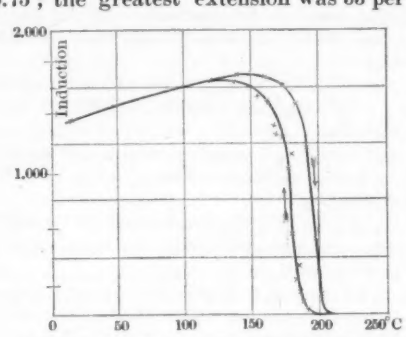
seen that in the two states of the metal (magnetizable and non-magnetizable) the resistances at ordinary temperatures are quite different. The specific resistance in the magnetizable condition is about 0.000052; in the non-magnetizable condition it is about 0.000072. The curve of resistance in terms of the temperature of the material in the magnetizable condition has a close resemblance to that of soft iron, excepting that the coefficient of variation is much smaller, as, indeed, one would expect in the case of an alloy; at 20 degrees C. the coefficient is about 0.00132; just below 600 degrees C. it is about 0.0040, and above 600 degrees C. it has fallen to a value less than that which it



CURVE 14.—33% NICKEL.

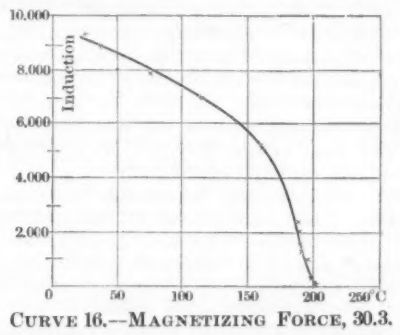
had at 20 degrees C. The change in electrical resistance effected by cooling is almost as remarkable as the change in the magnetic properties.

Samples of the wire were next tested in Professor Kennedy's laboratory for mechanical strength. Five samples of wire were taken which had been heated and were in the non-magnetizable state, and five which had been cooled and were in the magnetizable state. There was a marked difference in the hardness of these two samples; the non-magnetizable was extremely soft, and the magnetizable tolerably hard. Of the five non-magnetizable samples the highest breaking stress was 50.52 tons per square inch, the lowest 48.75; the greatest extension was 33 per cent., the



CURVE 15.—MAGNETIZING FORCE, 1.0.

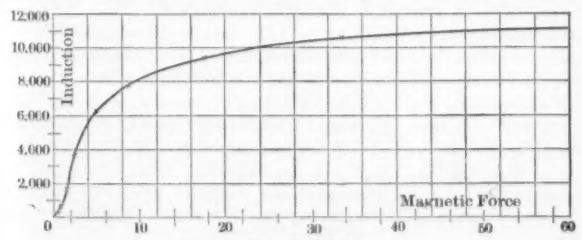
lowest 30 per cent. Of the magnetizable samples the highest breaking stress was 88.12 tons per square inch, the lowest 85.76; the highest extension was 8.33, the lowest 6.70. The broken fragments, both of the wire which had originally been magnetizable and that which had been non-magnetizable, were now found to be magnetizable. If this material could be produced at a lower cost these facts would have a very important bearing. As a mild steel the non-magnetizable material is very fine, having so high a breaking stress for so great an elongation at rupture. Suppose it were used for any purpose for which a mild steel is suitable on account of this considerable elongation at rupture; if exposed to a sharp frost its properties would be



CURVE 16.—MAGNETIZING FORCE, 30.3.

completely changed—it would become essentially a hard steel, and it would remain a hard steel until it had actually been heated to a temperature of 600 degrees C.

F. This sample contains 30 per cent. of nickel. Curve 12 shows the relation of induction to magnetizing force at the ordinary temperature, and Curve 13 the relation of induction and temperature for a force of 0.65. The remarkable feature here is the low temperature at which the change between magnetizable and non-magnetizable occurs, whether the temperature is rising or falling. Comparing it with the last sample, we see that the character



CURVE 17.—73% NICKEL.

of the material with regard to magnetism is entirely changed.

G. The analysis of this sample is:

Fe.	Ni.	C.	Mn.	S.	P.
66.19	33.0	0.28	0.50	0.01	0.02 per cent.

In Curve 14 is given the relation of induction and force at the ordinary temperature, and in Curves 15 and 16 the relation of induction and temperature for forces 1.0 and 30.3. The remarkable feature of this material is the complete difference from the last but one, and the low temperature of change. There is but very little difference between the temperatures of change when heated and when cooled.

H. The analysis of this sample, as furnished by Mr. Riley, is:

Fe.	Ni.	C.	Mn.	S.	P.
26 50	73.0	0.18	0.30	0.01	0.01 per cent.

In Curve 17 is given the relation of induction and force at the ordinary temperature. It is curious to remark that the induction for considerable forces is greater than in the steel with 33 per cent. of nickel, and that it is greater than for a mechanical mixture of iron and nickel in the proportions of the analysis, however the particles might be arranged in relation to each other.

The critical temperature of the material is 600 degrees C.; it shows no material difference between the critical temperatures for increasing and diminishing temperatures.

Electric Gas Lighting Company vs. Chas. E. Fuller.

The above suit was instituted by Messrs. Fuller, Holtzer & Co., and the following is the full text of Judge Colt's original decision, rendered on May 2 in the United States Circuit Court, District of Massachusetts. Arguments for a rehearing were heard on the 9th of August, and the original decision has just been reaffirmed. The court says:

"This is a bill in equity brought for the infringement of letters patent No. 225,071, granted to Henry F. Packard, and No. 232,304, granted to Frank V. Sanford, for improvements in electric gas lighting apparatus. The patents relate to that form of electric gas lighting where the burner is operated by hand, and which does away with the use of matches.

Packard says in his specification:

"'My invention consists in certain novel devices, hereinafter fully described, by means of which the gas is turned on by pressing or pulling down and then releasing a lever fitted loosely to the stem of the cock, and thereby causing a vibrating arm to sweep past the tip of the burner; also, in the combination, with the said devices of an electric contact point fixed upon the end of the said vibrating arm, and of a fixed electrode located in close proximity to the orifice from which the gas issues, one of the said electrodes being insulated from the burner, and which, by the action of the said devices, are caused to make and break contact when the gas is turned on, thereby producing an electric spark and igniting the gas.'

"The claims relied upon are the third and fourth, which are as follows:

"'3. In combination with a gas burner, *A*, and a fixed electrode, *n*, the rachet *D*, pawl *h*, spring *F*, lever *E*, pivoted loosely upon the stem of the cock and having two arms, *f* and *g*, to the latter of which is attached an elastic contact point, and stop pin, *k*, as and for the purposes set forth.

"'4. In an electric gas lighting apparatus, in combination with devices constructed and arranged to open and close the gas passage to the tip at each alternate movement thereof, and conjointly with such opening to ignite the gas by an electric spark generated by such movement, devices which shall, without actuating the gas cock, repeat the electrical spark by the return movement of the opening devices to their normal position for further use, substantially as described and shown.'

"The Sanford device is substantially like the Packard, with the addition of a chain which is attached to the arm of the lever. By pulling the chain with the hand, the burner is operated. The apparatus covering both of the patents is called the Packard-Sanford burner, and it appears to have been the first burner of this class which obtained any large degree of commercial success.

"The defence mainly relied upon is that there was no invention in what Packard did, in view of the state of the art at the time. It is not denied by the complainants that every element covered by the claims of the Packard patent may have been old, but it is said that they were never so combined before, and that the result is a great improvement over all prior devices of this class. The complainants insist that it is by taking one element from one prior patent and another element from another that the defendants seek to destroy this patent, and, in answer to this position, they cite the reasoning of the Supreme Court in Parks v. Booth, 102 U. S. 96, where, in stating the rule as to anticipation of a patented combination, the court says:

"'Where the thing patented is an entirety, consisting of a separate device or of a single combination of old elements incapable of division or separate use, the respondent cannot make good the defence in question by proving that a part of the entire invention is found in one prior patent, printed publication or machine, and another part in another, and so on indefinitely, and from the whole or any given number expect the court to determine the issue of novelty adversely to the complainant.'

"The constituents of the Packard gas burner are a fixed electrode, a stop-cock with one way or several ways, a ratchet rigidly secured so as to move with the stem of the cock, and having four teeth for a one-way stop cock, and a proportionably increased number of teeth according to the number of ways through the cock, an angle lever fitted loosely upon the stem of the cock, one of its arms for operating by hand, and the other extended so as to carry an electric contact point against and past the electrode fixed at the burner tip when the first arm is depressed, a pawl attached to the lever to engage with the ratchet, a spring to retract the lever when released after being depressed, and a stop pin to limit the movement of the lever. To light the gas it is necessary to pull down the lever arm once, whereby the pawl engages with and turns the ratchet which opens the valve and admits the gas through the orifice, while the other lever arm sweeps past the contact point across the fixed electrode, making and breaking the circuit and thereby producing an igniting spark; upon releasing the arm the spring will return the lever to its position, making another spark on its return, and, the pawl not engaging with the ratchet on its return, the gas will be left burning. To extinguish the gas a single pull will revolve the plug so as to close the cock, and the spring will return the lever to its position.

"No one of the prior devices, referred to by the defendants, discloses the combination of elements embraced in the Packard patent. Those devices at most contained but a part of the Packard mechanism, and, if practically operative, they seem to have been of doubtful utility. To have constructed the Packard apparatus and so made a practical and useful burner, I think showed invention.

"The Smith patent, No. 20,305, shows a ratchet wheel fixed to a gas cock, a lever moving freely on the gas-cock, a pawl which engages the ratchet, and an arm carried by the lever to the tip of the burner, but it does not show that the teeth of the ratchet are proportioned to the ways through the cock; nor is the curved magnet of Smith pivoted at its centre and carrying a rod, the two-armed lever of Parekard. The Smith arm is not carried past but only up to the burner tip, and from all that appears must be moved forward several times to turn on or off the gas. There are also other differences between the two devices.

"The Tirrell patent, No. 232,661, bears a closer general appearance to the Packard apparatus. The date of the Tirrell patent is subsequent to the Packard, but it appears that the Tirrell invention was prior in point of time. But in the Tirrell patent there is missing the ratchet, the pawl, the spring and the stop of Packard. It is said that all Packard did was to apply the ratchet and pawl, which were old, to the Tirrell structure, and that this was not invention. But he did something more than this. We must take the combinations in their entirety, and so viewed I do not think the Tirrell invention destroys the Packard patent. It is clear that the Packard device is a great improvement over Tirrell's, and that the combination of elements employed is different. For the same reason, and without entering into the specific distinctions between the two structures, the Heyl patent, No. 58,943, does not anticipate Packard. I find in none of the prior devices the combinations referred to in the third and fourth claims of the Packard patent, and recognizing the prior state of the art, I think it called for the exercise of the inventive faculty as distinguished from mere mechanical skill to produce the Packard burner. Upon the question of infringement I have no doubt.

"Decree for complainants."

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
167-177 TIMES BUILDING, NEW YORK, Aug. 30, 1890.

Subway Construction.—At a recent meeting of the Board of Electrical Control, a report of the construction of subways in 1890 up to date was presented by Mr. Beckwith. During this year 158,181 feet of trench have been dug and 774,926 feet of ducts have been laid, as against 56,035 feet of trench and 621,430 feet of ducts laid last year.

Mr. Smith Acker, of the firm of Acker & Bentz, electric wire contractors, Brooklyn, is about to close a contract for one 500-light dynamo at Rockville Centre, L. I. The transformer system of the National Manufacturing Company will be used. Mr. Bentz, of the same company, is installing a 500-light isolated plant for Mr. L. U. Cox at Washington, D. C.

The Hunt Engineering Company, of Brooklyn, has closed the following contracts during the last month: Ashley & Bailey's silk mill, at Paterson, N. J., 500 lights; National Needle Works, at Springfield, Mass., 325 lights; and the Republican Press Association Building, Concord, N. H., 300 lights. This company is doing the construction on all of these plants, including the power, plant and dynamos of the type made by the Standard Electric Company, of Vermont.

Fire in the Interior Conduit Factory.—The fire which partially destroyed the factory of the Interior Conduit and Insulation Company on Tuesday night, Aug. 26, started in the drying rooms, and, after burning many thousand feet of green or untreated underground tube and effecting the destruction of the underground curing apparatus, was checked, so that the output of underground conduits will only be temporarily restricted. Having kept the original factory on West Twenty-seventh street on interior conduit work, this branch of the company's business will not be interrupted, and, with the aid of additional temporary factory facilities secured in that neighborhood, the company will be enabled to aid the underground department materially. The burnt building will be immediately rebuilt, and a new structure, seven stories high, will be added. This will more than double the present accommodations and enable the company to keep pace with the extraordinary demand made upon it.

Electric Lights in the Fifth Avenue Theatre.—Mr. H. C. Miner has just refurnished the Fifth avenue theatre, and with his usual enterprise and judgment he has put in the electric light. The massive chandelier which hangs in the dome of the theatre is one of the main ornaments of the house. It was built by I. P. Frink, of this city, and cost Mr. Miner $1,500. It measures 30 feet from the brass ball at the end of the stem to the plate at the upper extremity of the stem and weighs 800 pounds. It contains 262 lights, gas and electric. The gas burners are made to resemble candles. It is proposed to light the house by electricity, the gas being reserved for supplementary purposes in any very special illumination. The lights can be used for scenic display, many effects being obtained by colored combinations. The lower circle contains 56 gas and 56 electric lights. It is surmounted by a silvered glass reflector. Above this circle and the reflector are ten clusters of lights, each made up of six gas burners surrounding three electric lamps. Six feet above this circle of clusters is still another of ten clusters, each made up of four gas lights surrounding two electric lights. The chandelier, which is richly ornamented with brass, can be raised and lowered at will, and the stem and pipes are silvered over or bronzed.

W. T. H.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
Room 8, Cook Building, cor. Franklin and Congress Sts.
BOSTON, Aug. 30, 1890.

The Boston Rubber Shoe Company, manufacturer of climax tape, has resumed operations after being closed for two weeks.

Mr. H. E. Townsend, of the Electrical Safety Company, is very sick. We trust that a favorable turn may soon occur, and that we shall be able to have him with us again shortly.

Mr. W. I. Barker, New England representative of the *Electrical Review*, has been very sick for the last two weeks, but at present is slightly better. We trust that he will be out again soon.

Beverly, Mass.—Ground was broken Monday morning for the new brick electric light and power station. When completed it will be one of the most commodious and best equipped in Essex County.

Peabody Citizens Do Not Want Electric Light.—A temporary injunction has been served upon the town of Peabody, Mass., on petition of Willard Spaulding and others, to prevent their expending the town money for a town electric light plant.

Mr. C. O. Harris and wife, of Dallas, Tex., are in Boston this week enjoying the "beans" and investigating all the old landmarks and relics. They are being well cared for by Mr. C. E. Bibber, of the Holtzer-Cabot Company, for whom Mr. Harris is Southwestern agent.

Mr. B. F. Merritt, electrician for the New England Printing Telegraph Company, was married at Jamaica Plain, Mass., to Miss Alice Walker on Wednesday of this week. After a short

bridal tour, the happy couple will take up their residence at Jamaica Plain.

Plantsville, Conn.—At a special meeting of the stockholders of the Connecticut Motor Company held this week it was voted to increase the capital stock from $30,000 to $40,000, the present stockholders to be given the preference in subscribing for the increase until October 1.

Lynn, Mass.—The Lynn and Boston Railroad has not yet taken action toward securing a location for an electric power plant in Lynn President Breed has been given the necessary authority to procure a site and it will probably be located on Sea, Broad or Beach streets. The fully equipped plant will probably cost about $75,000.

The National Telephone Company, which was before the Lynn aldermen for permission to string wires, offers a convenient method of communication for short distances. Its telephone is non-electric, and each subscriber is on an independent line. The majority of the stock is owned in Lynn. The petition was referred to the Committee on Streets.

Trolley System in Providence, R. I.—The special committee of the City Council on petition of the Union Railway Company for the introduction of the trolly system on its lines, has prepared a favorable report, which will be presented to the city government this week. The vote on its adoption it is said is likely to be close on account of the strong opposition from the electric light and telephone companies.

Lawrence, Mass—The Lawrence aldermen gave a hearing Monday evening on the petition of the Merrimack Valley Street Railway Company for new locations and the right to operate all lines by electricity. The system specified was the single trolley. The only remonstrance came from the New England Telephone and Telegraph Company, of Massachusetts, which sent a written protest. The board reserved its decision until Sept. 8.

Wakefield, Mass.—Col. C. F. Woodward states that Wakefield will have electric lights by the last of next month. The new stockholders of the Citizens' Gas Company will hold a meeting Wednesday for the election of directors. The work of erecting poles will begin at once. The new company will furnish electric power for the Wakefield and Stoneham Street R. R., and the work of building the railway will be started in the near future.

A New Electric Line Opened—The new car service to Eggleston Square, in Boston, goes into operation next Tuesday. On that date all horse cars will be taken off and electric cars will run between Forest Hills, Egleston Square and the Tremont House. New cars of the latest and best style have been provided for this line, and in the number are five eight-wheel open cars capable of seating 50 people. Some of the long box cars seating 40 people are being fitted up for the winter season.

Windsor, Conn.—The dam that the Farmington River Power Company is constructing at a point about three miles west of Poquonock is 30 feet across and 15 feet high. The project is to dam the river at this point and conduct the water by a canal about 30 feet wide to the wheelhouse, some 70 feet from the dam. About 40 men are now at work, and by the 1st of November the power developed will be carried over the wires to Hartford, a distance of about five miles. The turbine wheels are already on the ground which will give 800 h. p. The route for the wires to convey the power is now being surveyed. L. H. H.

WESTERN NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
465 The Rookery, Chicago, Aug. 30, 1890.

Plant Sold.—The Denver (Colo.) Electric Illuminating Company has sold its plant.

Mr. Walter Aufderheide has been appointed secretary of the Heisler Electric Light Company, of St. Louis.

The Lee Smoke Burner and Fuel Saving Company, of Chicago, has elected Mr. Arnold Brecher general manager of the company and has opened up offices at 137 Dearborn street.

Mr. C. A. Ross, special agent of the Thomson-Houston Electric Company, at Kansas City, Mo., has closed contracts for 650 light alternating incandescent plants at Maryville, Mo.; at Brookfield, Mo., and at Marysville, Kan.

Mr. Henry C. Eddy, 170 La Salle street, Chicago, has been appointed Western agent of the Consolidated Electric Storage Company, of New York and Philadelphia, and will push the sale of the Julien storage batteries in the West.

Mr. L. R. Curtis, of Mendota, Ill., is one of the few fortunate possessors of a complete file of THE ELECTRICAL WORLD from Jan. 6, 1883, to the present number. It may interest our readers to know that a complete file of THE ELECTRICAL WORLD was recently sold for a sum of over one hundred dollars.

Electric Lights for South Chicago.—The Calumet Electric Lighting Company, of which F. H. Watriss is the president, has asked for and obtained a permit from the Department of Public Works to erect poles and place electric lights on all streets from Eighty-seventh to One Hundred and Sixth, in South Chicago, the company having obtained an ordinance from that village before it was annexed to Chicago.

Mr. Charles D. Jenney, of Indianapolis, was a welcome visitor in Chicago on Sunday and Monday of this week. In referring to the business outlook, Mr. Jenney said his company had been kept so busy from the start in building first-class motors that a new factory of far larger capacity was soon required and the same is now being erected. With increased facilities for turning out motors, the company will soon be able to keep up with the demand.

Telephone Quotations.—Col. S. G. Lynch, broker, 153 Monroe street, Chicago, furnishes quotations on telephone stocks as follows:

Chicago	$298@$300	Cumberland	$ 59@ $60
Central Union	66@ 67	Wisconsin	116@ 117
Michigan	98@ 99	Bell of Missouri	140@ 145
Great Southern	30@ 32	Iowa Union	20@ 21
Colorado	38@ 40	Missouri and Kansas	55@ 57
Rocky Mountain Bell	40@ 45		

ELECTRIC LIGHT STOCKS.

Chicago Arc Light and Power	$104@$105	Chicago Edison Co	$125@$130

A Big Street Railway Contract.—The Thomson-Houston Electric Company, through Frederick Whitney Horne, representing its railway department, has just closed a contract with C. B. Holmes, John J. Mitchell and E. Buckingham, the Davenport & Rock Island Street Railway Company, for the construction and equipment of an electric street railway in Davenport, Iowa, and Rock Island and Moline, Ill. The amount involved in the contract is $150,000. There will be 20 miles of single track and five miles of double track, containing more than 60 curves, and 2,100 feet of track will be on bridges, including 1,500 feet over the government bridge. The overhead system will be employed, and the wires will be carried over the drawbridges on towers. The contract calls for 50 passenger cars, seven 100 h. p. generators, two 350 h. p. Corliss engines and three 300 h. p. Hazleton boilers. Construction will begin at once and will be completed, it is said, within 100 days.

F. DE L.

ENGLISH NOTES.

(*From our own correspondent.*)

LONDON, Aug. 20, 1890.

Silver Medal Awarded.—Messrs. Woodhouse and Rawson United, Limited, of London Eng., have been awarded a silver medal for their display at the exhibition of fire and life saving apparatus now being held at Amsterdam.

Lane Fox Patents.—Although the Lane Fox Company does not appear either by threats or by proffered negotiations to have gained any ground, an association has been formed with a view of protecting those who are concerned from the monopoly which it has sought to establish. This association also proposes to protect its members from the other schemes which are threatened by the owners of control patents.

The City of London and the Electric Light.—This district, which occupies only about one square mile of this metropolis, has been eagerly sought after for lighting purposes by different companies for the last seven years. The four-mile radius from Charing Cross, embracing an area of 12½ square miles, does not by any means contain the whole of London proper. The city of London has been divided into three portions. Two of these have been allocated, the most easterly to Messrs. Laing, Wharton & Down, the representatives of the Thomson-Houston system, and a slice of the middle has been secured by the Brush Corporation, who, of all other companies, have been the most persevering in repeated tenders, negotiations and estimates ever since 1883, in which year several of the streets were experimentally lit by them from their factory at Lambeth. The contract for the third and westerly portion has not yet been given. You will notice that both of these firms may said to be of American origin. The conditions of the specification imposed by the City Commissioners are of a very severe character, a powerful section of the corporation having strongly opposed the electric lighting, and another portion having wished to do it themselves. None of the companies, who have been supplying other parts of London, have been allowed, up to the present, to extend their wires into the city. There have been a few isolated private plants at work inside the city boundary, but these will not have so important an effect on the city district as the numerous large installations for lighting clubs, hotels, museums, etc., which have skimmed the cream of the work in other parts of London, in a manner, which must be very objectionable to the supply companies.

News of the Week.

THE TELEPHONE.

Memphis, Tenn.—The Postal Telegraph and Cable Company has secured permission to erect poles and wires in Memphis, and an office will be established there at once.

Covington, Ky.—J. S. Freshour, S. S. Kimberly and J. P. Dieters have incorporated the West India & Columbia Telephone Company with a capital stock of $100,000.

Monthly Statement.—The statement of the output of telephones by the American Bell Telephone Company for the month ended Aug. 20 makes the following comparisons:

August—	1890.	1889.	Increase.
Gross output	4,322	4,302	20
Returned	2,761	2,471	290
Net output	1,561	1,831	*270
Dec. 21 to Aug. 20—			
Gross output	42,686	38,640	4,046
Returned	17,752	16,152	1,610
Net output	24,934	22,498	2,436

*Decrease.

The total number of instruments in use Aug. 20, 1890, was 469,795, against 434,039 at the corresponding date last year, an increase of 35,756.

THE ELECTRIC LIGHT.

Milford, N. H.—An electric light plant is to be established.

Beeville, Tex.—It is stated that an electric light plant will be erected.

Arkadelphia, Ark.—The erection of an electric light plant is projected.

Winchester, Tex.—The erection of an electric light plant is projected.

Dallas, Tex.—The Dallas Ice Factory will put in an electric light plant.

Darlington, Ky.—It is reported that an electric light plant will be erected.

Memphis, Tenn.—Frank R. McGeoy wants prices on electric lighting fixtures.

Petersburg, Va.—Thomas Pannill will, it is stated, erect an electric light plant.

Greensboro, Ala.—Charles E. Waller wants bids for furnishing an electric light plant.

Anderson, S. C.—The Anderson Hotel Company wants a 200-light incandescent dynamo.

Selma, Ala.—The Selma Electric Light and Gas Company will put in an incandescent plant.

Winchester, Tenn.—G. L. Hogan & Co. are erecting an electric light plant to cost $10 000.

Laconia, N. H.—Improvements to the extent of $10,000 are being made to the electric light plant.

Buckannon, W. Va.—The Buckannon Electric Light Company will purchase an electric light plant.

Anderson, S. C.—The Anderson Hotel Company will put in a 200-light incandescent electric light plant.

Benwood, W. Va.—It is reported that the Riverside Iron Works has erected an electric light plant.

De Land, Fla.—The De Land Electric Light and Ice Company has been incorporated with a capital stock of $150,000.

Anderson, Cal.—The Anderson Water Company is talking of putting in an electric light plant of 200-light capacity.

Stroudsburg, Pa.—The Penn City Electric Company has been incorporated with a capital stock of $2,000.

Wellsville, O.—The Valley Electric Light and Power Company, has been incorporated, with a capital stock of $25,000.

Columbia, Pa.—The Electric Light Company has been awarded a contract for street lighting for a period of three years.

Parkersburg, W. Va.—The city council is considering the advisability of the city owning its own electric light plant.

Franklin, La.—J. A. Morris and A. B. Baker have, it is reported, erected an electric light plant at their sugar mill.

Washington, Ga. It is stated that contract has been awarded for the erection of the incandescent electric light plant.

Windsor, Ont.—The Reliance Electrical Company has been awarded the contract for erecting an electric light plant.

Quanah, Tex.—The Quanah Water, Ice and Electric Light Company has been incorporated. The capital stock is $75,000.

Port Townsend, Wash.—The Port Townsend Electric Light Company has increased its capital stock from $25,000 to $50,000.

El Paso, Tex.—The El Paso Gas, Electric Light and Power Company has been incorporated with a capital stock of $300,000.

Dover, Del.—The Dover Electric Light Company is making arrangements to increase its plant to three times its present size.

Shenandoah, Va.—The Shenandoah Land and Improvement Company will soon commence the erection of an electric light plant.

Huntington, W. Va.—The Thomson-Houston Electric Company contemplates the erection of an electric light plant in Huntington.

Monroe, N. C., will hold an election to decide as to the issuance of $25,000 of bonds to improve streets and erect an electric light plant.

Greensboro, Ala.—The Greensboro Electric Light Company has been organized to erect an electric light plant. The capital stock is $5,000.

Keokuk, Ia.—The Keokuk Hydraulic and Electric Company has been granted a franchise to furnish electric light and electric and water power.

McKeesport, Pa.—The McKeesport Electric Light Company is about to put $30,000 in a new building and the enlargement of its present plant.

Wheeling, W. Va.—The Wheeling Electric Company contemplates erecting a new building for its electric light plant and doubling its capacity.

Birmingham, Ala.—It is stated that the Edison Electric Light Company and the Birmingham Electric Light and Gas Company will consolidate.

Galveston, Tex.—The Westinghouse Electric and Manufacturing Company is now occupied with the installation of a 25-light plant at Galveston, Tex.

Dubuque, Ia.—The City Council has contracted for 100 electric light lamps to be put at street intersections, for which $75 per year for each lamp will be paid.

Installation Rules.—The Pacific Insurance Union has just issued a set of rules and requirements for the installation of electric light and power plants.

Winchester, Tenn.—G. L. Hogun & Co. want a second-hand 200 light alternating dynamo and 150-light direct current dynamo also 12 second hand arc lamps.

Hicksville, O.—The Hicksville Electric Light Company will erect 10 additional street lights immediately. Mr. W. F. Horton is the secretary of the company.

Galveston, Tex.—The Citizens' Electric Light Company will, it is reported, purchase the electric light plant of the Brush Electric Light and Power Company.

Rock Hill, S. C.—The Rock Hill Electric Light Company has let the contract to the National Manufacturing Company for the erection of the electric light plant.

Cuero, Tex.—The Cuero Oil Company has contracted with the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., for an incandescent plant.

Saginaw, Mich.—The City Council has decided that the Bartlet Illuminating Company be awarded the contract for lighting the city, and to require it to bury its wires.

Macon, Ga.—The Central City Guano Company has contracted with the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., for an incandescent plant.

Terrell, Tex.—A stock company has been organized to erect an electric light plant and has awarded the contract for same. John L. Terrell, mayor, can give particulars.

Quincy, Ill.—The City Council has awarded the contract to the Thomson-Houston Company to furnish 200 lights for one year for $19,000, all additional lights to cost $95, each.

Montgomery, Ala—The Citizens' Electric Light and Power Company, with P. B. Bibb, president, has been granted a franchise by city council to erect an electric light plant.

Cohasset, Mass.—The Cohasset Electric Light Company has been incorporated with a capital of $30,000. Work on the new plant has already begun. A. G. Lawrence is president.

Moundsville, W. Va.—The Moundsville Electrical Company has awarded the contract to the Fort Wayne Electric Company, of Fort Wayne, Ind., to erect an electric light plant.

Spartanburg, S. C.—The Spartanburg Oil Company has contracted with the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., for an incandescent plant.

Orangeburg, S. C.—The Orangeburg Electric Light and Electric Power Company has been incorporated by E. F. Slater, J. M. Oliver and C. G. Danzler to erect an electric light plant.

Edgefield, S. C.—The Edgefield Gin and Mill Company has contracted with the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., for a 50-light incandescent plant.

Warrenton, Va.—A flour mill is to be erected, and the same power will be used to operate an electric-light plant, which will be owned by the town. C. W. Rosenberger can give information.

Gas Displaced.—The Mendota Electric Light Company, of Mendota, Ill., has just completed the installation of 105 incandescent street lamps, thus displacing gas for street lighting in that city.

Bryan, Tex.—The Bryan Water, Ice and Electric Light Company has contracted with the Westinghouse Electric and Manufacturing Company, of Pittsburgh, Pa., for a 500-light incandescent plant.

El Paso, Tex.—The El Paso Gas, Coke and Coal Company, with a capital stock of $100,000, and the El Paso Gas, Electric Light and Power Company, with a capital stock of $300,000, have been incorporated.

Easthamptom, Mass.—At the annual meeting of the Peoples Electric Light Company the following officers were elected: President, Chas. W. Smith; treasurer, H. G. Knight; directors, Thos. Sawyer and John Mayher.

Marysville, Kan.—The Marysville Light and Power Company has been incorporated with a capital stock of $5,000. Chas. F. Koester, Perry Hutchison, S. A. Fulton, Geo. W. Parrish, A. R. Shumway, are the incorporators.

Radford, Va.—The Radford Water and Light Company has been incorporated with H. P. Chew, president, and G. E. Cassel,

secretary, to operate water-works and to erect an electric light plant. The capital stock is $150,000.

Tulare, Cal.—The Tulare Electric Light and Power Company has been incorporated by F. W. Eaton, John C. Turner, George A. Davis, H. C. Miller and C. D. Cushing. The capital stock is $50,000, of which $10,000 has been subscribed.

Logan, Utah.—A new electric light company has been organized with a capital of $100,000. The plant will be located three miles up Logan Cañon, where there is plenty of water power, and will be large enough to supply all demands.

Lawrenceville, Va.—The Lawrenceville Land and Improvement Company has been incorporated with E. B. Lewis, president, and N. S. Turnbull, vice-president, to improve land, erect an electric light plant, etc. The capital stock is $10,000.

Napa, Cal.—The Napa Thomson-Houston Light Company has been incorporated with a capital stock of $50,000, of which $30,000 has been subscribed by the following directors: Thomas Addison, Samuel H. Taylor, Max Caspari, Charles P. Ells and William H. Waite.

Washington, Pa.—The authorities of the borough have voted to abandon natural gas for street lighting. The company furnishing the gas complains that there is too much waste connected with the illumination and the borough will be in the near future lighted by electricity.

Windsor Beach, N. Y.—The electric light works and pumping station of the Rome, Watertown & Ogdensburg Railroad has been destroyed by fire. The engine, boiler, pumping machinery and the large dynamo, together with other electric light machinery, were totally destroyed.

Birmingham, Ala.—J. F. B. Jackson, R. M. Mulford and Robert Jemison have incorporated the Consolidated Electric Light Company to manufacture and sell electrical power and appliances. It is also authorized to manufacture gas for fuel and lighting purposes. The capital stock authorized is $500,000.

The McKeesport (Pa.) Light Company is in a flourishing condition. Its business has recently been growing rapidly and the management has decided to provide dynamo capacity for 100 per cent. increase. The Edison incandescent light is used in connection with Waterhouse arc-lighting apparatus.

Bucksport, Me.—At the annual meeting of the stockholders of the Bucksport Electric Company, the following officers were elected: President, E. H. Gowing, of Bangor; vice-president, Fred. S. Palmer, of Bangor; treasurer, John Post, Jr., of Boston. It was voted to double the capital stock, making it $30,000.

Richmond, Va.—The contract has been awarded to the Edgemoor Bridge Works for building an iron and steel viaduct 1,200 feet long and 40 feet wide, connecting the properties of the Highland Park and Northside land companies with Richmond. It is reported that an electric light plant will be erected on the land.

Sedalia, Mo.—The Sedalia Electric Light Company, which has been operating an alternating current electric light plant of the Westinghouse system for over a year, is about to enlarge its capacity. The company has just contracted for a 75-light alternating current apparatus with the Westinghouse Electric and Manufacturing Company. This will give the plant a total capacity of 1,500 lights.

Traverse City, Mich.—The Westinghouse Electric and Manufacturing Company has received the contract for a 500-light alternate current apparatus from Traverse City, Mich. The Electric Light Company at that place has been operating the Westinghouse alternate current incandescent system for some time, but the demand for incandescent lighting has grown so rapidly that this increase has become necesesary.

Suffolk, Va.—The Suffolk Light and Water Company, which is under contract to furnish Suffolk with electric lights, has been organized with the following officers: President, Capt. C. H. Causey; vice-president and general manager; E. Wilkerson, secretary, and treasurer, C. E. Causey, Jr.; directors, C. H. Causey, E. Wilkerson, C. H. Causey, Jr., W. B. Causey and Geo. L. Barton. The amount of the capital stock is $25,000.

An Electric Light Plant for the Navy.—The Thomson-Houston Company has been awarded the contract for furnishing an electric light plant for the United States Cruiser "Newark." The plant will consist of three sets of dynamos and engines, each dynamo being directly connected and secured to the same bedplate as the engine driving it. The dynamos will be compound wound, and will be run at a speed of 400 revolutions per minute. They will have a capacity of 200 ampères at 80 volts pressure, and the specifications call for an efficiency of not less than 80 per cent. at full load. The insulation resistance of the entire system, including the circuits of the dynamos, must not be less than 100,000 ohms. The incandescent lamps are to be of 10, 16, 32 and 50 c. p., placed at various parts of the ship, the total number of lamps being 425. The ship is also to be furnished with four Mangin projectors of the latest type, each supplied with two combination lamps.

Arc Light Carbons.—A statement of the carbon industry in Cleveland says: There are four carbon manufactories in the city, the Brush Electric, National, Standard, and the Globe. The two first mentioned are controlled by the Thomson-Houston Co., and the Standard and Globe companies are independent. Those four concerns manufacture 60 per cent., or 54,000,000 of the 90,000,000 carbons used annually in the United States. A factory owned by the Thomson-Houston Co., at Fremont, turns out 10 per cent. of the total production, but it is usually accounted a part of Cleveland, and this city is given credit for 70 per cent. It is said that the output of the Globe Company is about 5,000,000 carbons yearly. There are two factories in St. Louis and one in Pittsburgh. For years the Brush Company stood at the head of the business, but other companies entered the field, and during the rapid development of the business they secured important positions. From the time of the introduction of electric lighting, however, this city has been in the lead and has practically controlled the production.

APPLICATIONS OF POWER.

Richmond, Va.—Warner Moore and his associates intend constructing an electrical railroad if permission can be secured.

San Antonio, Tex.—The South Heights Rapid Transit Street Railway Company will build an electrical railroad 2½ miles in length.

Savannah, Ga.—The Real Estate Loan and Building Company will construct an electrical railroad. J. S. Collins can give information.

Toledo, O.—An electric railway is to be built at once from Toledo to Maumee, O., a distance of 12 miles, and the franchise stipulates that the fare for the round trip is to be 12 cents, or half a cent a mile.

Fort Payne, Ala.—Books of subscription have been opened for the construction of a street railroad. True P. Pierce can give information.

Covington, Ky.—The Cincinnati, Covington & Rosedale Electric Street Railroad Company intends constructing an electrica railroad shortly.

Newport, Ky.—The Newport Electrical Street Railway Company has been organized, with H. M. Healey, president, and H. Buchanan, secretary and treasurer.

Oakland, Cal.—An ordinance granting a franchise to John Coleman, W. D. English, and others, for an electric railroad from West to East Oakland, has been granted.

Frankfort, Ky.—Fayette Hewitt, P McDonald, J. W Pruet and others are the incorporators of the Capital Railway Company, organized to construct an electrical railroad.

Tonawanda, N. Y.—The Electrical Accumulator Company, of New York, has made an offer to the Tonawanda Street Railroad Company to furnish storage battery cars of guaranteed efficiency.

Jacksonville, Fla.—It is said that an electrical railroad will be constructed to the property of the Jacksonville Driving Park Association. Hon. P. McQuaid or J. P. Taliaferro can give information.

Site for a Power House.—The Toledo (O.) Electric Street Railway has purchased a site for a new power station for $20,000. The building and equipment of the station will cost $300,000, and it will be completed without loss of time.

Louisville, Ky.—Mr. Harold P. Brown spent some time at Louisville recently experimenting on a noiseless electric car for the consolidated railway lines. A trial trip was made on the West Walnut and Green street electric line with some of the officers.

San Jose, Cal.—J. H. Henry, the owner of the electric road now in operation in San José, has deposited $15,000 toward the purchase of the Central Street Railroad of Sacramento. The purchase is conditional on the granting of a franchise for an overhead electric system.

Santa Clara, Cal.—The Santa Clara Supervisors have granted to Jacob Rich a franchise for an electric railroad along Hedding, Walnut, and Hobson streets, to the city limits of San José. This will be a continuation of the First street line. The system is to be overhead.

Boise City, Idaho.—The Boise City Rapid Transit Company has been formed. The capital stock is $20,000 The object of the company is the construction of an electric street railway in Boise City. Nearly $5,000 is subscribed, and the cars will be running by the middle of October.

Pennsyvania Railroad Electric Cranes.—Two cranes built by Wm. Sellers & Co., each equipped with Sprague motors, one of 10 h. p., the other of 15 h. p., 220 volts, using the overhead double trolley, have been installed by the Equitable Electric Railway Construction Company, of Philadelphia, in the shops of the Pennsylvania Railroad Company.

Tacoma, Wash.—J. C. Todd, of St. Paul, representing the Thomson-Houston Electric Company has closed a contract with the Tacoma and Puyallup Street Railway Company for the construction and equipment of that company's line. The contract price is $250,000, and is to include the entire construction of the road and its successful operation for two months, at the end of which time it will be turned over to the local company if accepted.

Annual Report.—The Pleasant Valley Railway Company of Allegheny City has filed the following report with the department of internal affairs at Harrisburg: Capital stock, $1,300,000; number of passengers carried during year ending June 30, 1890, 4,583,900; total receipts, $231,379.03; expenses, $153,644.97; surplus, $61,441,153. The West End Railway Company of Pittsburgh carried during the year 1,412,453 passengers. Its gross revenue was $87,186.91, its expenses $59,064.50.

Electric Cranes.—On the traveling crane which is now running in the erecting shop of Wm. Sellers & Co., with a capacity of 50 tons and a length of runway of about 200 feet, is a Sprague electric motor with a capacity of 15 h. p. Current is taken from an Edison compound wound dynamo of 50,000 watts capacity. The double overhead wire, using Wheeler double overhead trolley is in use. The plant was installed by the Equitable Electric Railway Construction Company, of Philadelphia, and has been in operation about nine months.

The Pleasant Valley Electric Street Railway Company at Pittsburgh, Pa., is having constructed at its power house a novel switchboard, said to be the only one of the kind in the United States. The size of the board is 8 × 6 feet. Its composition is brick and terra cotta lumber. The face of the board is covered with a coating of cement. The Pleasant Valley people are proud of their power house, as they have aimed to make it as nearly as possible fire-proof. It is said that there is no more complete power house in the country.

The McKeesport Street Car Company is running a horse line in the town, and has been for a couple of years. The company has enjoyed a fair share of prosperity, but the spirit of progress will not allow it to be content with animal motive power. Electricity is to be adopted as soon as possible. The company asks the borough to give it rights upon the streets to be traversed and free it from license fees. In return for the favors it is willing to make a four-cent fare for three years, and thereafter a three-cent fare to purchasers of a quarter's worth of tickets.

An Order Quickly Filled.—An order for six electric cars for the Elmira, N. Y., electric road was booked by the John Stephenson Company, Limited, on the evening of Wednesday, July 30. The material was taken from the stock room, the cars were constructed and completely finished and the motors all attached, the wire and trolley fixtures put in place, and the cars shipped ready for service on Aug. 21, 22 and 23, respectively—two each day. On Aug. 25, Col. D. C. Robinson, president of the railroad company at Elmira, announced by telegram the arrival of the cars in good order.

A New Westinghouse Railway.—A few days ago the Lansing & North Lansing railway line, of Lansing, Mich., commenced operation, and according to all accounts, everything went off with the greatest success. This is a street car company which has adopted the Westinghouse electric railway system, and the officials of the road are very generous in their praise of the system. A gentleman who was present at the starting of the cars stated that, although the motor men were all green hands, the cars ran without a hitch and in a perfectly successful manner. The opening of the line was quite an event in Lansing.

The McKeesport Passenger Railway Company, which has been using horses as its motive power, has experienced considerable difficulty in having its lines extended, and President James Evans, of the Bank of McKeesport, has written a letter to the Council suggesting that the railway company be given the right of way to extend its lines out Fifth avenue to the city line, out Walnut street to Christy Park and thence over the hill districts through Evans and Irwin avenues, provided it agrees to adopt electricity as its motive power within a year. Representatives of the company say they will agree to this plan.

The McGavock & Mount Vernon Railroad Company, of Nashville, Tenn., originally installed six 16-foot cars, and since that time a consolidation of the various lines has been effected, all being electrically equipped. Some 75 cars are now in operation, mules having been entirely superseded. Messrs. Curtis & Draw, agents for the Thomson-Houston Electric Company, have just closed a contract with the Nashville syndicate for an eight car equipment for the Savannah Street and Rural Resort Railway Company, of Savannah, Ga., which they have just acquired by purchase. The same firm, through its isolated lighting department, has recently closed contracts for the Carniegie Music Hall, Brevoort House, Morris Park Club House and a number of other isolated lighting plants.

The Squirrel Hill Railway Company. Pittsburgh, Pa., which is erecting an electric line, has been having trouble with the city. An account of the difficulty has already appeared in THE ELECTRICAL WORLD. The line of the company as laid out comes in contact with Schenley park, the new and highly popular resort just opened by the city. The city fathers tried hard to put a stop to the erection of the line upon that part of the route tapping the park, but their efforts have been fruitless. The railway company obtained its right of way prior to the time at which the ground comprising Schenley park was given the city, and it is the general opinion that nothing can prevent the completion of the road. Judge Mager has refused to grant to the city a preliminary injunction against the railway company.

A New Railway Projected.—The following named gentlemen of Uniontown, Pa.—Wm. G. Hay, John Gilmore, John A. Nichols, J. S. Douglass and Thomas R. Wakefield—will apply to the governor for a State charter on Sept. 11, for an intended corporation to be called "The Citizen's Electric Street Railway Company." These gentlemen are well known and possess ample capital. The road will be built on Main, Morgantown and Fayette streets and out Mt. Vernon and Gallatin avenues. The length of the road will probably be three and a half miles. They agree to commence work on the road within six months from the time the charter is granted. Some of the gentlemen named are connected officially with the Uniontown Electric Light and Power Company, while the members of the Uniontown Light and Heat Company are recognized as being interested in the proposed electric railway mentioned in a recent number of THE ELECTRICAL WORLD. Both applications for charters go before the Governor at about the same time, and it is thought by some that both companies will not be granted charters However, a borough ordinance has already been passed in favor of one of the railways, and Uniontown is reasonably sure to have an electric railroad at an early date, even if there is no opposition.

Street Railway Progress in Louisville, Ky.—The first electric line in Louisville was started with three 80 h. p. Thomson-Houston generators. Now the Fourth, Sixth, and Second, Market and Eighteenth, Market and Shelley, Brook and Seventh, and Parkland Suburb lines are to be made electric at once and all the others as soon as possible. Complete electrical equipments have been ordered for the lines above mentioned, including the dummy line to Jacob Park which will be completed in ninety days if there is no further trouble about the right of way. It will connect with the Fourth avenue electric cars for the city at the Churchill Downs race course. The Fourth avenue line will be completed in sixty days and the other lines in rapid succession, the poles already being up for the Market street lines. The stringing of the overhead wires for the Fourth street line has already begun. The power house of the consolidated companies has to be enlarged and this is now being done. It will be more than three times its former capacity. In addition to the three 80 h. p. Thomson-Houston generators, the Edison General Electric Company, has just closed a contract through its local agent, Mr. Campbell, Scott, for three 200 h. p. Sprague generators to be delivered at once for the Seventeenth and Walnut street power house. Then later, as needed, the equipment is to be furnished for the new power house at Logan, and Jacob streets, which will be almost a duplicate of the Seventeenth street house, except that it will have four of the 200 h. p. Sprague motors. A central power house on South Fourth street will be erected as soon as the Eastern is built, and equipped in the same way. It is estimated by Superintendent Thomas Minary, of the consolidated lines, that it will take a central station plant of 7,000 or 8,000 h. p. capacity to operate the entire number of cars in use in the city.

Industrial and Trade Notes.

The Pettingell Andrews Company has secured the contract for all the supplies and wire for the Woodsville (Vt.) and Wakefield and Milton (Mass.) central stations.

Nubian iron enamel is said to be an excellent covering for all metal work and far cheaper than the material usually employed. It is prepared by the Nubian Iron Enamel Company, Chicago.

Hartford, Conn.—The Jewell Belting Company is building a five-story addition 96 × 60 to its belt factory, made necessary by the very largely increased business it has been having mainly from the electrical field.

The Gethins Batteries in large numbers are being used by the New England Phonograph Company. Four of these are used to charge each storage cell and they are doing their work in an excellent manner.

Julius Andræ, Milwaukee, Wis., manufactures a special "loy" called the Andræ loy, that is said to be unexcelled for use in digging holes for electric light poles, having given satisfaction during the past ten years.

The National Electric Company, of Philadelphia, is doing an excellent business with its patent single and double pole fuse blocks. Their compactness, ease of renewal of fuses and sliding glass case make them a very superior article.

The Brown Electric Protector Company, of New England, reports large orders from the Gamewell Fire Alarm Company and the New York, New Haven & Hartford Railroad for its protectors. The company is also receiving numerous orders from the West and South.

The Swain-Goodsell Metallic Packing Company, Chicago, has received letters from superintendents of plants showing where its metallic packing has been in constant use for many months, in one case for more than 34 months of 24 hours run each day. A better record could not be desired. This packing is always sent on 30 days' trial.

Geo. M. Stevens, manufacturer of the "Stevens" fire alarm box, at 15 Chardon street, Boston, is about to make extensive additions to his factory. New machinery is to be added, and his office is to be enlarged to double its present size. Mr. Stevens is at pre-

sent doing double the amount of business of a year ago, and present indications are for a larger increase during the coming year.

A New Company.—The Eastern Electrical Supply and Construction Company will open offices Monday, Sept. 2, at 74 Federal street, Boston. This company has a capital stock of $50,000 and is the sole agent for J. H. Bunnell & Co., of New York, and will also control the territory of Massachusetts for the auxiliary fire alarm. Some well-known electrical and financial men are connected with the company.

The Standard Underground Cable Company intend that its new manufacturing plant at Brinton shall be a very complete affair. Connected with the plant will be a rolling mill for the rolling of brass, and a copper wire mill for the making of all the copper wire needed by the company. The copper to be worked up in the mill will come from new mines in Montana in which Mr. George Westinghouse, Jr., is largely interested.

Mr. W. S. Hill, the well-known electrical expert at 133 Oliver street, Boston, is having a large run on his double pole switches. The new Hill double pole converter switch, by the use of which the converter can be completely cut off from the primary circuit, thereby avoiding all possibility of danger while working on the converter or on the secondary circuit, is some hing that has been long needed by central station men. A number of stations have already been equipped with it, and report it as working splendidly.

The Shipman Engine Company, of Boston, which makes small engines in sizes from one to eight horse power, is securing considerable electric business. The automatic action of fuel and water supply and unvarying speed make this engine a most desirable one for small isolated electric plants, running small dynamos all kinds, charging storage batteries, etc. The company has already some very flattering testimonials, and has lately shipped five of its engines to San Francisco. At present orders are being filled from Massachusetts, Connecticut and Kansas.

The Beacon Vacuum Pump and Electrical Company has just moved into its new factory on Irvington street, where it will build at once six eight-cylinder Beacon pumps under the Berrenburg patents. Its new location is a fine one for light, air and room. The main workroom has 10,000 square feet of floor space, and is at present being fitted with the following new machinery: One Brown & Sharpe automatic grinding machine and one milling machine of the same make; one Henday planer and Putnam lathe; three Fitchburg lathes; two Hill, Clarke & Co. lathes; one Prentice Bros. and one Lodge & Davis drilling machine; one Lodge & Davis bead lathe, turret hea l; one Fannel Tool Company "Rivet" lathe. The company is also fitting new machinery for the manufacture of a new electric meter which will be a novelty in its way, and promises to be of great value to the consumer.

The Taylor Manufacturing Company, of Chambersburg, Pa., reports a large business during the past few weeks, and report sales of their automatic engines, built under patents of R. M. Beck, to the following parties: one 12½ × 15 engine, with complete plant, to the Butler (Pa.) Light and Motor Company; one 11 × 12 engine to the Devon Electric Light Company. Devon, Pa.; one 11 × 12 engine, with complete steam plant, for the Kittanning (Pa.) Thomson Houston Electric Light Company; one 14 × 15 engine, with four boilers, for Fort Scott (Kan.) Rapid Transit Company; one 14½ × 18 engine to People's Gas and Electric Light Company, Canton, Ill.; one 14½ × 18 engine, with complete plant, for the Streator (Ill.) Gas and Electric Light Company. Of the vertical automatic type of engines, the company reports sales of engines on combination base with dynamo, to the H. B. Plant Company, for the steamer "Naugatuck," of New York City, and two engines to the United Edison Manufacturing Company, of Toronto, Canada; also a 7 × 7 vertical automatic engine on plain base to the Edison Company for West Bay City, Mich.; another engine of the same size and style to Carnegie Bros., of Pittsburgh, Pa., for their works at Bessemer, Pa.; a 5½ × 6 vertical engine, on plain base, to the Quaker City Electric Light Company, for Lancaster, Pa.

An Excellent Smoke Consumer.—The Lee Smoke Burner and Fuel Saving Company, of Chicago, is introducing the Lee smoke consumer, a device that two years' practical experience has shown to be one of the simplest, most economical and best devices on the market for solving the smoke problem, from the fact that it can be attached to any furnace at slight cost, requires no expert stoking, and permits of the use of the lowest grades of coal. The invention is that of Mr. James D. Lee, of Chicago, and consists of a method whereby there is withdrawn from the stack at a point close to the furnace a constant supply of hot air that is returned to the furnace at several inlets placed just above the bed of live coals and which materially assist in the total combustion of the gases that would otherwise escape through the stack and pollute the air with particles of carbon. The device consists of a pipe corresponding in size nearly to that of the stack, of a revolving fan and of several pipes of small diameter through which the hot air is forced into the furnace. The power required in operating this device has not exceeded 1 per cent. of the total amount generated, while the actual saving effected in the amount of fuel consumed has averaged about 30 per cent. of the amount previously consumed for doing the same class of work.

Sealine is a liquid paint for insulating and fireproofing all kinds of electrical apparatus, iron work, etc., and is particularly adapted to the insulating, waterproofing and fireproofing of wire joints or connections, exteriors of cables, converter boxes, cut-out blocks, dynamo brasses, lamp holders and hoods, painting the exterior of wires, switchboards and numerous other electrical apparatus where heavy currents are apt to attack wood work. An example of its fireproof qualities was shown where a soft pine board had been painted and allowed to dry; a blaze of fire was allowed to attack the painted wood for a long time and enough to ordinarily ignite soft pine, the paint not being affected in the least, although ordinary paint would be ignited or peeled. The Seely & Taylor Manufacturing Company, 24 Cortlandt street and 19 Dey street, New York City, is the sole manufacturer of this liquid paint, and is prepared to sell it in any quantity, from a one pint can to a barrel. The company is willing to send a sample of the paint to any responsible electric light power or railway company. This paint is considered a necessity to all well constructed installations, as it will resist acids, and is also water proof. The company's S. and T. compound has also been favorably received. It can be applied to all classes of electrical apparatus where a high resistance material is needed for cut-out blocks, switch bases and bases for all kinds of electrical apparatus, battery covers, and parts of instruments where a thorough insulator is needed.

Answers to Correspondents.

Questions to be answered in this column must be of general electrical interest, and must be accompanied by real name and address as a guarantee of good faith. No notice will be taken of questions regarding apparatus unless enough details are given to permit a definite answer, and no dynamo or motor designing will be done.

Electric Gas Lighting.—Please explain how the sparks are obtained for a simultaneous electric ignition of a number of gas jets from a distance; also, how the wires are arranged. J. M.

The spark is obtained either from an induction coil or from some form of an influence machine, like the Holtz machine. The wires are generally laid from burner to burner, arching up over the top, and leaving a very minute gap for the passage of the spark, so that the gaps will be in series. Quite a long spark is desirable. Of course, in many cases it will not be necessary to light all the gas burners, as in a run of jets in a large hall or theatre sometimes the lighting apparatus is arranged to light every other jet, and intermediate ones catch from the adjacent flames.

A Fusible Alloy.—Can you give me proportions of Wood's alloy, of which the melting point is said to be about 150° Fahr.? Is it composed of lead, tin, cadmium and bismuth? (2) Can you give me the name of some dealer from whom the cadmium and bismuth can be bought in small quantities? R. R. B.

(1) Wood's alloy is composed of the following constituents and proportions: Lead, 2 parts; tin, 4 parts; bismuth, 7 parts; cadmium, 2 parts.

(2) You can obtain cadmium and bismuth from any large dealer in chemicals. You will probably get it easiest by sending through your local druggist. If you care to send for it yourself, you might try Eimer & Amend, New York City.

Hysteresis.—Will you please define for me the term "hysteresis"? I suppose it is the resistance offered by soft iron to rapid change of position of magnetic polarity, or to rapid reversal of magnetic polarity. C. F. A.

Hysteresis is properly molecular friction to magnetic change of stress. When a bar of iron is rapidly magnetized and demagnetized, a considerable amount of energy is consumed in the process; in other words, it is found to require quite a perceptible amount of work done upon the material to reverse the magnetization in opposition to this sort of internal friction that we call hysteresis. The quantity may be quite large; in some dynamos, for example, not less than ⅛ h. p. is wasted in doing this work upon the iron parts of the machine.

Trouble with a Dynamo.—I notice in your issue of Aug. 23, under the head of "Answers to Correspondents," that "W. C. H." is having trouble starting his eight-light dynamo. I had occasion some time ago to examine a machine similar to the one he has made. I first tried the machine as a motor, and it ran fairly well. I then tried it coupled up as a series dynamo machine and got no results. I next tried the armature with the field separately excited, and obtained good results. But on taking a small coil of wire and placing inside of it a compass, I found that the needle did not deviate. I at once concluded that the armature was giving me an alternating current. I then took down the machine, uncoupled the commutator, and went to work on it with a compass and one Leclanchè cell, found out where the trouble was, recoupled the commutator, and the machine has been giving good results ever since. W. C. P.

Permanent Magnets.—We have made a number of horseshoe permanent magnets of chrome magnet steel 4½ inches long, and of section $\frac{1}{16} \times \frac{5}{8}$ of an inch. They were made very hard, and charged to saturation by a powerful helix on the Edison circuit, but in a few days they lost nearly all of their strength. Can you suggest a remedy? SUBSCRIBER.

Chrome steel requires a very powerful induction to magnetize it thoroughly. As regards its magnetic properties, however, different specimens vary very widely, some specimens of chrome steel being little better than very ordinary steel. Would advise you in future to look out for the quality of the steel you use. As to the magnets already made, they should be re-magnetized in the same direction and the current kept circulating around them for a very considerable time. Tempering in oil gives rather the best results for magnet steel, and perhaps you would find it desirable to retemper the magnets.

Concerning a Motor.—(1) I have a 10 h. p. stationary C. & C. shunt wound motor, and have applied carbon brushes and also inserted a pole-changing switch in the armature circuit, so as to run the motor in either direction, with apparently better results when running in the direction the machine was intended for. Could I get better results by inserting the pole changer in the fields and letting the armature circuit remain as originally intended? (2) Is the winding of a motor intending to run in both directions different from what it would be if only intended to run in one direction? (3) What would be the effect of applying carbon brushes long enough to extend over three segments of the commutator when running? (4) What is a good book on the practical construction of electrical motors? MOTOR.

(1) You will probably find with shifting the brushes on your machine, so that the backward trail will be the same in whichever direction you are running, that your motor will run as well in one direction as in the other. Most motors are made to run in one direction, and the brushes are given a backward trail with that in view. To change direction you must shift the brushes. Better leave your pole changer where it is. We would not recommend reversing the magnetism of the field magnets in a shunt machine every time you change the direction of its rotation. (2) The winding for either class of motor would be the same, but in a motor intended to reverse precautions are taken in designing the field magnets and pole pieces so that the brushes will require as little control as practicable, in which case, as in the street car motor, the armature may be reversed without shifting the brushes at all. (3) You will probably find your motor heating if you use the brushes too wide. Use a carbon brush with but little more contact surface than a copper brush. (4) Carl Hering's "Principles of Dynamo-Electric Machines" will give you some excellent suggestions on the designing of motors, for in all essential particulars motor and dynamo are the same, and a machine intended for one will generally run perfectly well as the other, providing the lead of the brushes is changed, it being forward in the dynamo and backward in the motor.

Business Notice.

Three Links.—Travelers on business or bent on pleasure, invariably visit one of the great cities of the West, if their journey is at all prolonged. Nowhere else can be seen such centres of enterprise and American vim as in Chicago or Kansas City, and few invite lovers of elegance and beauty like St. Louis. In going farther into the "Great West" there are various routes the tourist may select from, but supposing the start is made from Chicago the great starting point of western travel, no line can be found more desirable than the Chicago & Alton, the great "Three Link" route, and its unsurpassed connections. Elegant cars, courteous train men, a first-class track, and every convenience that modern railroading employs is here found for safety and comfort. The country traversed is unexcelled for beauty of scenery—the veritable garden of the continent. Be sure and secure tickets of the Chicago & Alton if you would have a pleasant journey.

OUR ILLUSTRATED RECORD OF ELECTRICAL PATENTS

U. S. PATENTS ISSUED AUGUST 19, 1890.

434,427. Thermo-Electric Battery; Harry Barrington Cox, of New Haven, Conn., Assignor to the Electric Generator Company, of Portland, Me. Application filed March 6, 1889. In thermo-couples, a conductor or radiator placed within the circuit of the same to produce a fall in thermic potential.

434,428. Thermo-Electric Generator; Harry Barrington Cox, of New Haven, Conn., Assignor to the Electric Generator Company, of Portland, Me. Application filed Jan. 9, 1890. In a thermo-electric generator, the combination, with a fire-pot or furnace open at the top, of a cylindrical thermo pile around and extending above the open top of said fire-pot, forming an upper continuation of the same, so that the heat is applied direct to the elements of the pile.

434,429. Thermo-Electric Generator; Harry Barrington Cox, of Hartford, Conn. Application filed June 13, 1890. In thermo electro couples, a series of radiators or conductors placed within the circuit of the couple to produce a fall in thermic potential.

434,444. Secondary Battery; Thomas H. Hicks, of Detroit, Mich. Application filed July 8, 1889. The combination of a series of plates combined together, with insulating frames between them, said frames being made of greater width than the battery plates, whereby vertical recesses or grooves are formed between the projecting ends, and of water cement in said recesses.

434,450. Electric Welding Clamp; Herman Lemp, of Lynn, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed March 29, 1890. In an electric metal working apparatus the combination, with the clamping devices having means for applying initial lateral pressure to the work, of a clamping jaw adapted to tighten automatically on endwise movement of the work under it.

434,457. Electrode for Batteries, and the Method of Making the Same. David Pepper, Jr., Philadelphia, Pa. Application filed Oct. 14, 1889. The invention involves an electrode for primary or secondary batteries, consisting of a plate or plates of active material having cavities formed in their mass and provided with an integral support and connection of fusible metal filling said cavities and included and protected by the active material.

434,458. Method of Making Secondary Battery Plates; David Pepper, Jr., of Philadelphia, Pa. Application filed March 7, 1890. The method of manufacturing plates for conversion into electrodes, which consists in mixing with an oxide or salt of lead a fusible and soluble salt, placing the mixture in a mold and heating it to the point of fusion of the fusible and soluble salt.

434,468. Method of Welding; Russell Robb, of Boston, Mass., Assignor to the Thomson Electric Welding Company, of Maine. The method of electric welding consisting interposing a piece or pieces of fusible conducting material between the parts to be welded, and applying pressure so as to cause the softened interposed material to assume any irregularities in the surfaces upon which it abuts.

434,488. Electric Power Transmission; Elihu Thomson, of Lynn, Mass. Application filed May 7, 1888. The invention consists in a system of electric power transmission, comprising a feeding main or wire conveying a current which is continuous or unipolar in its character, and which is supplied with current from a central station or point, a second main carrying alternating currents supplied from any suitable source, and one or more electric motors at another point fed from said mains, and having their armatures connected with the alternating main and their fields connected with the unidirectional current main.

434,489. Electric Power; Elihu Thomson, of Lynn, Mass. Application filed Oct. 9, 1890. The combination, in a system of electrical distribution, of mains of approximately constant potential supplied from a suitable generator, translating devices connected to and supplied from such mains in multiple arc, and compensating electric storage devices constantly connected across said mains at or near the point of consumption or connection of the translating devices where variations of load or potential are immediately felt with variations in the demand of the translating devices.

434,500. Thermo-Electric Generator; Harry Barrington Cox, of Hartford, Conn. Application filed June 13, 1889. A thermo-electric generator having its surface exposed to the heat coated with fireproof material and fluted, corrugated or otherwise irregular.

434,501. Electric Meter; Jules Cauderay, of Paris, France. Application filed Aug. 9, 1889. Patented in France, Dec. 18, 1888. In an electric meter and register the combination of an electric measuring device, such as a watt meter, ampère meter or the like, and a time measuring device, an integrator or device, for determining the resultant or product of the current passing and the time during which it passes, and a register for recording such resultant or product, the integrator and register both being controlled and actuated by the one time measuring device.

434,509. Ceiling Block Connector; Charles W. Huntington, of Baltimore, Md. Application filed Nov. 29, 1889. The invention consists of the combination of a base or cap, the former provided with metallic sockets and the latter provided with metallic springs adapted to enter said sockets and hold the cap in place against the base. These metallic pieces, while serving to secure the parts together, also convey the electric current.

434,520. Process of and Apparatus for Forming and Welding Metals by Electricity; Elihu Thomson, of Lynn, Mass., Assignor to the Thompson-Electric Welding Company, of Maine. Application filed Aug. 8, 1889. The invention consists in a novel process, consisting in passing through the metal a current of sufficient volume to soften or render the same plastic and then swagging metal into the form desired in a drop press.

434,531. Induction-Discharge Protector for Welding Apparatus; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Aug. 8, 1889. The invention consists in removing the danger to the primary from a melting down of the work in the secondary circuit by placing an induction discharge protector across the terminals of the primary and adapted to provide a path for a high tension induction discharge while maintaining an insulation which will prevent a shunting of the ordinary currents passing through the primary of the coil for the purpose of setting up the low tension currents in the secondary.

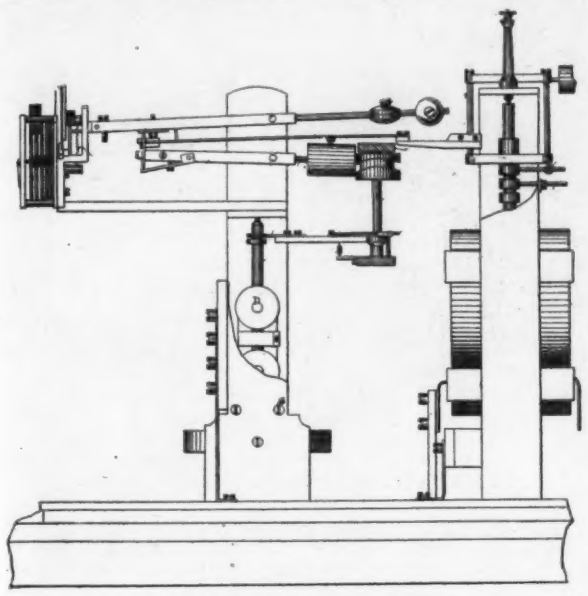
434,532. Process of Electric Welding; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson Electric Welding Company, of Maine. Application filed Dec. 23, 1889. The method of electric welding which consists in applying lateral compressing or condensing force to the weld during the application of the endwise welding pressure or force, which tends to upset the metal, so far as to form a lateral expansion at the joint.

434,557. Volt or Ampere Meter; Rudolf Eickemeyer, of Yonkers, N. Y. Application filed Dec. 17, 1889. In a meter for measuring volts or ampères, the combination with an exciting coil of a pivoted indicator composed mainly of non magnetic material weighted for maintaining it in its normal position and provided with small pieces of iron, whereby when an electric current is delivered to the coil prompt magnetic saturation is secured in one or more of the pieces of iron and the liability of objectionable permanent magnetism reduced to a minimum.

434,558. Device for Measuring the Intensity of Magnetic Currents; Rudolf Eickemeyer, of Yonkers, N. Y. Application filed Dec. 23, 1889. A magnetic current measuring device containing a pivoted measuring needle normally controlled by a spring and a pivoted adjuster pointer or needle which will freely conform to direction of magnetic lines, and enable the measuring needle to be properly located in and adjusted with reference to any magnetic current to be measured, whereby said measuring needle will be deflected in proportion to the capacity of the current to overcome the power of the spring.

434,579. Apparatus for Transferring Electric Car Batteries; F. G. Corning, of New York, N. Y. Application filed May 21, 1890. In an apparatus for transferring and recharging electric car batteries, the combination of a rack having several charging benches arranged in series in different horizontal planes, wherein the batteries are distributed, and a car hoist for conveying the car from one level to another in a path parallel with the said series of benches.

434,580. Apparatus for Transferring Electric Car Batteries; Frederick G. Corning, of New York. Application filed May 31, 1890. The invention consists in the combination, with a vertically movable platform or section of car track flanked by the battery charging racks, wherein the batteries are placed in vertical series of an ascending grade or grades of track or inclined plane whereon the car is conveyed to an initial level



No. 434,501.—ELECTRIC METER.

from a final level of the said movable platform or equivalent by the transaction of its running gear.

434,581. Apparatus for Transferring Electric Car Batteries; Frederick G. Corning, of New York, N. Y. Application filed June 4, 1890. The invention consists, in conjunction with a car stall at the re-charging station, of vertically movable battery racks flanking the car track in the stall, wherein by the movement of said racks any of the vertical series of charging benches therein may be brought to a level with the battery receptacles in the car preparatory to shifting the battery trays horizontally.

434,582. Mechanism for Transferring Electric Car Batteries; Frederick G. Corning, of New York, N. Y. Application filed June 9, 1890. The invention consists, in conjunction with a horizontal transferring surface or way upon or through which the batteries are to be shifted, of propelling wheels or rolls stationed in the paths of movement of the battery trays to engage them either by frictional or positive contact.

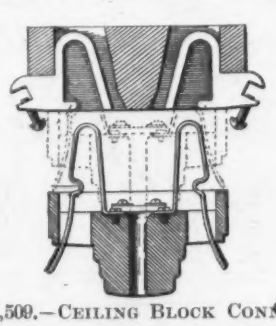
434,585. Telegraph Relay; Thomas A. Edison, of Menlo Park, N.J. Application filed Aug. 9, 1880. The combination of an electro-magnet, a magnetic armature, and a conducting material whose resistance is varied by pressure situated between the core of said magnet and adapted to be compressed by said armature upon its attraction by said magnet.

434,586. Electric Generator; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Jan. 30, 1888. The combination, with a magnet and a conductor within the influence of the field of force of said magnet, of a body which is caused to expand and contract by variations of temperature and acts to produce movements at such field of force whereby electric currents are induced in the said conductor.

434,587. Thermo-Electric Battery; Thomas A. Edison, of Llewellyn Park, N. J. Application filed Jan. 30, 1888. In a thermo-electric couple or battery, the combination of two metals having a moving contact, with a source of heat acting upon one of such metals, the other metal being heated only by conduction at the point of contact.

434,588. Magnetic Ore Separator; Thomas A. Edison, of Llewellyn Park, N. J., and William K. L. Dickson, of Orange, N.J. Application filed Jan. 20, 1890. The method of separating magnetic material from non-magnetic material, which consists in agitating the mixed pulverized materials in a magnetic field, transferring the magnetic materials and particles adhering thereto to a second magnetic field in a higher horizontal plane by the combined action of a moving body and magnetic attraction and further agitating the materials in the second field.

434,589. Propelling Mechanism for Electric Vehicles; Thomas A. Edison, of Llewellyn, N. J. Application filed Feb 20, 1890. The combination of a rotating shaft on a vehicle, a reciprocating pitman connecting to the shaft and to a pivoted frame supporting the head or pivot-pin of the propelling rods, and



No. 434,509.—CEILING BLOCK CONNECTOR.

means for raising and lowering said head, whereby the speed may be varied while the vehicle is in motion without changing the speed of rotation of the shaft.

434,590. Dynamo Electric Machine; Justice B. Entz, of New York, N. Y., Assignor to Thomas Alva Edison, of Llewellyn Park, N. J. Application filed Dec. 6, 1888. The invention consists in arranging the field magnet poles so that all the poles of one sign are in the ring armature and all the poles of the opposite sign outside of it. It further consists in only one exciting coil or helix for all the field magnet poles, such coil being wound outside of all the poles of one sign and inside the poles of the other sign.

434,593. Galvanic Battery; Wm. M. Fink, of Elizabeth, Assignor of two-thirds to Sherman Cooper and Philip Hathaway, both of Westfield, N. J. Application filed March 19, 1890. The chloride of silver rod, with a central wire having attached thereto a silver foil or other metallic connections in the shape of transverse silver wires or silver-wire gauze, such foil or other connections being so constructed as to fold over at their points at the surface of the chloride of silver, and to afford complete electrical connection between such surface and the interior portions of the road.

434,596. Electric Push Button; Philip Hathaway, of New York, N. Y. Application filed May 24, 1890. In an electric call bell apparatus, the combination of case constructed to contain a battery, circuit closing mechanism, and connections with the line wires of a call bell a dry battery loosely in such case and movable between two contact points, and means for pressing the electrodes of such battery against the surfaces of each contact points.

434,614. System of Electrical Distribution; Henry E. Walter, of Schenectady, N. Y. Application filed May 16, 1889. The combination, in a system of electrical distribution, with main conductors and translating devices in multiple arc, of a ground connection from one of said chambers, and a device in said ground connection adapted to develop a counter electromotive force.

434,640. Thermal Battery; Hugo Mestern, of Munich, Germany. Application filed January 6, 1890. In a thermo-electric or furnace-battery, a pair of electrodes, one of which is provided with screw threads engaging similar threads on the casing or mantel of another electrode.

434,671. Electric Valve Closer; Lemuel Mellett, of Boston, Mass., Assignor to himself, A. D. Tingley, A. L. Russell and A. P. Lighthill, all of same place. Application filed Jan. 22, 1889. The invention consists of the combination, with a steam shut-off valve of an engine, of an electric circuit, magnets and armature, a spring actuated lever, a latch for engaging said lever and arranged to be operated upon by the armature, and connections between the spring actuated lever and shut off-valve whereby the latter may be operated.

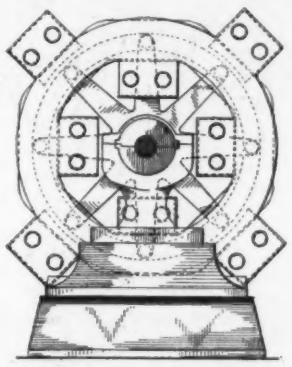
434,682. Trolley for Electrically Propelled Cars; William L. Stephens and Edwin J. Wescott, of Boston, Mass. Application filed Oct. 16, 1889. The combination with an electrical trolley-support, of a hollow perforated shaft carried thereby, a trolley wheel mounted on the shaft, and an oil receptacle communicating with the interior of the shaft.

434,684. Electric Railway System; Charles J. Van Depoele, of Lynn, Mass. Application filed Aug. 12, 1889. An electric railway system comprising a source of current of relatively high potential and supply conductors carrying the current and extending along the line of way, a moving vehicle provided with a motor generator, a multiplex local circuit moving with the vehicle and successively receiving currents of reduced tension, and one or more motors for propelling the motor and supplied with current from the said local circuits.

434,685. Alternate Current Electric Railway-Train System; Charles J. Van Depoele, of Lynn, Mass. Application filed Aug. 16, 1889. An electric railway system comprising a circuit of working conductors along the line of travel, a source of alternating or discontinuous currents connected to said conductors, a traveling vehicle provided with current collecting devices engaging the said working conductors and with a system of inductional transformers and means for controlling the current therein, and suitable electric motors arranged to propel the vehicle and connected in the secondary circuit of the transformer system.

434,686. Electric Railway Train System; Charles J. Van Depoele, of Lynn, Mass. Application filed August 21, 1889. An electric railway train system comprising a supply circuit carrying current of relatively high tension along the line of way, a motor car provided with a current converter arranged to receive and be operated by the high tension current, one or more vehicles connected and moving with the motor car and carrying conductors connected to form a local circuit supplied by the converter with current of relatively low tension.

434,687. Electric Railway System; Charles J. Van Depoele, of Lynn, Mass., Application filed Aug 13, 1889. Renewed July 3, 1890. An electric railway system comprising a plurality of vehicles, a plurality of electric motors arranged to propel said vehicles, a local circuit carried by the moving vehicles and including all the said motors and reversing



No. 434,590.—DYNAMO ELECTRIC MACHINE.

switches connected with the circuit of each of the said propelling motors, and means for operating all of the circuit controlling switches from any desired point.

434,716. Electric Belt and Appliances; Robert E. Williams, of Dallas, Tex., Assignor of one-half to Wilber F. Snook, of same place. Application filed Feb. 26, 1890. In a battery for electric belts and the like, consisting of a series of connected cells, the combination, with an innermost folded zinc plate, of a zinc sleeve incasing the same, felt cloth surrounding the sleeve, a wire connecting link or bail contacting with this zinc sleeve, an outer casing of copper having its edges at the end adjacent to the bail which contact with the zinc sleeve cut away or concaved, and a wire bail connecting with the opposite end of the copper blank.

434,816. Multiple Circuit Electric Motor; Charles J. Van Depoele of Lynn, Mass. Application filed Oct. 28, 1889. An electric motor having multiple field magent poles and multiple circuits therefor energized successively, and an armature energized by the common return of all the independent circuits.

434,827. Electric Railway; Adelos Gorton, of Camden, N. J. Application filed Nov. 7, 1889. In an electric railway a conductor having its entire surface covered with insulating material except at distant intervals, a brush with rollers, and plugs and transmitters, each of the said plugs and transmitters furnishing seats or contacts at the same time for two of the rollers, and the brush being of such length as to span two of the said plugs, and its rollers so close together that one will contact with a plug before the advance roller leaves the same plug, said parts being combined.

434,835. Portable Electric Signaling Device; Peter Pearson, of New York, N. Y. Application filed April 2, 1890. The invention relates to an improved means for transmitting signals from one point to another by a portable device embodying a bell and mechanism to operate it intermittingly when electrical connection is established and broken between the sending and receiving points.

434,853. Contact Box; Ferdinand A. Wessel, of Brooklyn, N. Y., Assignor to the Excelsior Electric Company, of New York. The invention consists in forming the series of contacts from a number of plates of metal clasped together with the bared ends of the leading wires fastened between them, together with suitably interposed sheets of insulating material and in providing the conducting contact plates with grooves or depressions adapted to receive the bared ends of the leading wires.

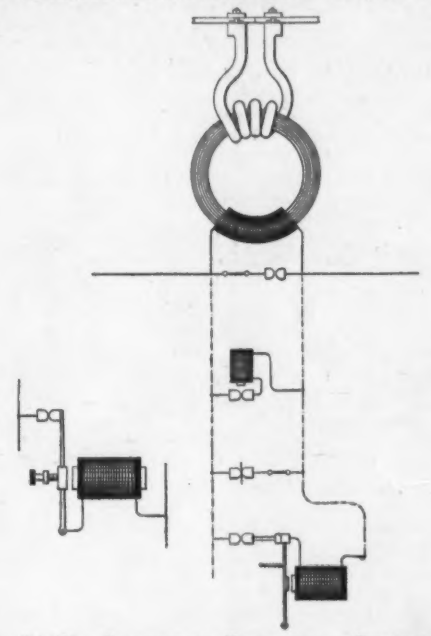
434,863. Apparatus for Transferring Electric Car Batteries; Frederick G. Corning, New York, N. Y. Application filed May 26, 1890. In an apparatus for transferring and recharging electric car batteries, the combination with a movable platform or section of car track for receiving the car and transporting it to different levels and a car having battery receptacles opening at the sides thereof, of a charging rack (or pair of racks) which flank the platform or movable track and its path of movement in immediate proximity to the vertical plane of movement of the sills of the said battery receptacles.

434,869. Secondary Battery Plate; William B. Hollingshead, of Bronxville, assignor of one-half to Sydney H. Carney, of New York, N. Y. Application filed March 6, 1890. In a plate for secondary batteries, the combination of active material, as red lead, black oxide of manganese, or other non cohesive substance, and an integral inclosing crust of porous material.

434,871. Electric Railway; Rudolph M. Hunter, of Philadelphia, Pa., Assignor to the Electric Car Company of America, of same place. Application filed June 9, 1886. In an electric railway, a working conductor, from which a traveling motor receives electricity, made in sections arranged end to end, part of which sections supply electricity of one polarity and part electricity of the opposite polarity.

434,879. Electric Insulator; Samuel Oakman, of Melrose, Mass. Application filed Sept. 13, 1889. In an insulator, the combination of the petticoat and a series of internal annular projections having inclined tops and flat bases adapted to act as water-stops.

434,880. Recording Telegraph; John S. Odell, of Chicago, Ill., Assignor to the Printing Telegraph Company, of Illinois, of same place. Application filed Nov. 21, 1887. In telegraph apparatus, the combination, with the main line, of a transmitter comprising mechanism for reversing the normal condition of the main line circuit and for holding the main line circuit in said reversed condition, and differential mechanism arranged to restore the normal condition of the circuit at the ends of different periods of time after the normal condition has been reversed, and a series of keys, each arranged and adapted to operate the mechanism that reverses the condition of the main line circuits and arranged and adapted also to bring into action its corresponding part of the differential mechanism for restoring the normal condition of the main line circuit whereby by the operation of the different keys the passage of current over the main line can be differentially



No. 434,531.—INDUCTION DISCHARGE PROTECTOR.

controlled to impart correspondingly differential movements to appropriate mechanism of a receiving instrument.

434,881. Printing Telegraph; John B. Odell, of Chicago, Ill., Assignor to the Printing Telegraph Company, of same place. Application filed Feb. 8, 1889. In a printing telegraph, the combination, in a transmitter, of a series of keys and a series of individual contact points operatively connected with the keys, and a movable arm provided with several circuit changers, each arranged to engage with certain of the contact points, and suitable means for restoring said arm to its starting point, and suitable means for connecting the transmitter with a receiver.

434,882. Speed-varying Mechanism; John F. Ott, of Orange, N. J. Application filed Feb. 20, 1890. The combination of a rotating shaft on a vehicle, a reciprocating pitman connected to the shaft and to a pivoted frame supporting the head or pivot pin of the propelling rods, a bell crank lever, a link between the head and one arm of the bell crank lever, and means for operating the lever.

434,885. Electric Conductors; William A. Phillips, of Schenectady N. Y., Assignor to the Edison Machine Works, of same place. Application filed March 25, 1889. The combination, of a wire, of flat strips of absorbent insulating material applied longitudinally to said wire, the strips being individually in a folded condition.

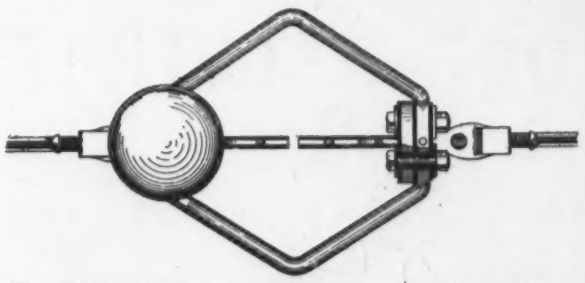
434,892. Binding Post; Gordon J. Scott, of Schenectady, N. Y., Application filed April 29, 1890. The combination, in a binding post, of a conducting terminal, to which a conductor wire is connected, two wedge-shaped conducting pieces adapted to be supported in a socket of corresponding shape, and means for locking the parts together, thus holding the same in said socket.

U. S. PATENTS ISSUED AUG. 26, 1890.

11,108. Regulation of Electric Arc Light Circuits; Daniel Higham, of Boston, Mass., Assignor to the Higham Patent Right Co., of Rockland, Me. Application for reissue filed Aug. 1, 1890. The mode for regulating and stabling arc-circuit currents at a constant intensity, consisting, when the current rises above normal, in first dropping the potential to check the rise of current, and then raising the potential while the current is still above normal or when a fall of current occurs, in first raising the potential, but dropping it again while the current is below normal.

434,917. Hanger for Incandescent Lamps; Paul J. Chasagne, of Akron, O., Assignor of five-eighths to S. Samuel Miller and William R. Palmer, of same place. Application filed June 6, 1888. The invention consists of a rotable spool having suitable electric connections so that the lamp may be raised or lowered at will without interfering with the electric current.

434,922. Non-Interfering Signal Box; William E. Decrow, of Boston, Mass., Assignor to the Gamewell Fire Alarm Telegraph Company, of New York, N. Y. Application filed December 27



No. 434,961.—INSULATOR FOR OVERHEAD CONDUCTORS.

1887. The combination of the pull or operating device of a signal box with a lock for said pull normally impelled toward the position to engage with and fasten the said pull and an electro-magnet and armature therefor movable independently of said lock and in its normal position being engaged with said lock to restrain it from movement into position to engage the pull.

434,925. Ceiling Fuse Blocks; Horace A. Fitch, of New Bedford, Mass. Application filed March 11, 1890. The combination of a base adapted to be secured to a wall or ceiling, and having recesses, notches, contact plates secured to the base over the recesses and connecting with main wires, a block having a central opening, resilient contacts on said block, lugs extending from the block engaging with the contact plates on the base, the heads of said lugs passing into the recesses beneath the plates and a tubular bracket arm extending from the block.

434,943. Electric Connector; Edward L. Orcutt, of Somerville, Mass. Application filed Feb. 6, 1890. The invention consists of a tube having a tapered end and split at one or more points in its periphery, which is adapted to inclose the wire to be connected, and then be driven forcibly in a corresponding hole in the web of the rail or other piece to which the attachment is to be made.

434,949. Gearing for Electrically Propelled Vehicles; Nathan S. Possons, of Cleveland, Ohio. Application filed May 28, 1890. An electric motor having its armature insulated by way of the mounting and provided with gearing comprising one or more wheels, with webs of wood or noise deadening non-conducting material, whereby said armature is also insulated by way of its transmitting gearing.

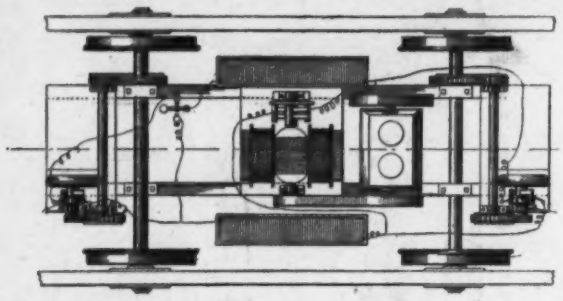
434,951. Dash-Pot; Michael Raughtigan, of Norwich, Conn., Assignor of one-half to Frank C. Turner, of same place. Application filed July 2, 1890. The combination, in a dash-pot, of an inclosing shell, piston and piston rod having a central longitudinal

opening with lateral openings, and a tube fitted to move longitudinally on said piston rod to cover or expose said lateral openings.

434,961. Section Insulator for Overhead Electric Conductors; Elihu Thomson, of Lynn, Mass., Assignor to the Thomson-Houston Electric Company, of Conn Application filed March 10, 1890. In a connector for line conductors on electric railways, the combination of two cars attached to the two ends of the line sections, respectively, and an open metallic frame connecting the said cars, but insulated therefrom, the said frame sustaining the cars so as to provide an air space between their ends and around them.

434,992. Insulator; Charles Oswald Muehlberg, of Pittsburg, Assignor of one-half to Henry Stamm, of Mount Oliver, Penn. Application filed May 22, 1890. The combination, with an insulator, of a sliding rod to which the conductor is to be attached, said sliding rod being borne by the insulator.

434,993. Motor for Street Cars; William H. Patten, of Chicago, Ill., Assignor to the Patten Motor Company, of Pueblo, Colo. Application filed Oct. 9, 1889. The combination, with a car and car axles of an independent frame extending from axle to



No. 434,993.—MOTOR FOR STREET CARS.

axle and supported thereby, an electric motor and a dynamo carried by the independent frame beneath the car floor, a motor mounted on said frame to drive the dynamo, and storage batteries electrically connected with the dynamo and the electric motor and co-operating with the dynamo for starting the car.

435,011. Trolley for Electromotor Cars; Samuel David Cairns, of Troy, N. Y., Assignor of three-fourths to Dennis J. Whelen, Wm. J. Roche, and James T. Quinn, all of same place. Application filed February 19, 1890. The combination, with a trolley arm that is pivoted at its lower end to the car top, and operated with its upper end to engage with the under side of an overhanging circuit wire by means of spring when said arm is projected upward from either end of the car, of two bracket arms projected from the upper end of the trolley arm to be in line with each other, a trolley pulley arranged on each side of said bracket arms, and an elastic connection made between said bracket arms and each of said trolley pulleys.

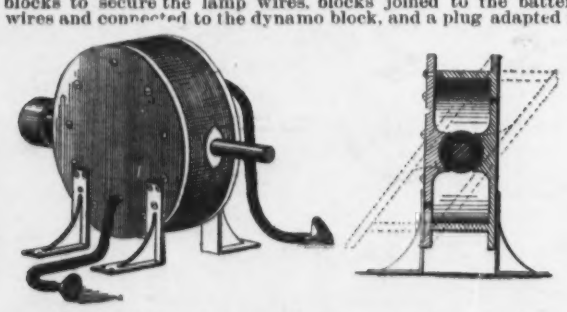
435,015. Dynamo Electric Machines; William Forman Collins, of New York, N. Y., Assignor of one-fourth to William A. Rosenbaum, of Jersey City, N. J. Application filed July 27, 1889. The machine has but a single field coil, which is wound upon an iron spool, the heads of which are in the form of discs, having pole pieces projecting inward toward each other from their centres. The spool is made hollow to accommodate the armature, and in some cases the commutator and brushes, which are mounted upon a shaft running at right angles to the axis of the coil.

435,024. Incandescent Lamp Socket; Frederick C. Rockwell, of Hartford, Conn. Application filed Feb. 19, 1890. In combination, in a socket bearing electrical conductors, a reciprocating bolt projecting through the wall of the socket, a ratchet in the path of a projection from the bolt, and a rotary button connected with the ratchet, so placed between the conductors that at alternate periods during rotation the conductors are forced to make and break a circuit.

(1) 435,029. (2) 435,047. (3) 435,048. (4) 435,049. Cut-Out for Electric Lamps; Incandescent Lamp Sockets and Keys; Walter F. Smith, of Philadelphia, Pa., Assignor to the United Electric Improvement Company, of Gloucester City, N. J. Applications filed (1) April 24, 1890; (2) Aug. 23, '89; (3) May 5, 1890; (4) May 26, 1890. (2) The combination, in an electric lamp, of two vertical supports, a short circuiting lever, pivotally connected with one of said supports, a spring interposed between said lever and support, a metal plug provided with a threaded shank mounted in the other of said supports, an insulated thumb piece mounted thereon, a tube or rod melting or softening at a low temperature, mounted in said plug, and a metallic ferrule secured to the opposite end of said tube or rod. (3) The combination, in an electric lamp, of two supports, a short circuiting lever pivotally attached to one of said supports and provided with a right angular projection, a spring interposed between said lever and support, a metal plug connected with the other of said supports and provided with an insulating thumb piece, and a disc or pellet of a vulcanized mixture of rubber and graphite supported in the plug.

435,030. High-Resistance-Shunt Compound; William George Bremer, of St. Louis, Mo., Assignor to the United Improvement Company of Gloucester City, N. J. Application filed June 6, 1890. A hard high resisting compound or composition formed of rubber, graphite, and sulphate of baryta dissolved by a solvent and rendered hard, but melting or softening at a moderate temperature.

435,084. Electric Lighting System; Alexander H. Bauer, of Chicago, Ill., Assignor to the Pullman's Palace Car Company, of same place. Application filed Aug. 10, 1889. In an electric lighting system for railway cars having a dynamo, a storage-battery and one or more lamp circuits, a switch mechanism, comprising contact blocks to receive wires from the dynamo, separate blocks to secure the lamp wires, blocks joined to the battery wires and connected to the dynamo block, and a plug adapted to



No. 435,015.—DYNAMO ELECTRIC MACHINE.

be inserted between the battery and lamp circuit blocks whereby to complete the lamp circuit.

435,093. Electric Switch; Charles H. Herrick, of Winchester, Mass. Application filed May 16, 1890. The combination, with the rotatable spindle, having an arm, of a pivoted switch bar of greater radial length than the said arm, a spring interposed between and carried by the said arm and the outer end of the switch bar, and the co-operating contacts.

435,097. Electric Signal for Cable Railways; Solomen J. Jacobs, of New York, N. Y. Application filed Dec. 12, 1889. The invention relates to means whereby the conductor or brakesman upon a cable railway car may at will signal a station when assistance may be necessary, as, for instance, when a grip should cease to operate successfully.

435,098. Automatic Disconnector for Overhead Conductors; Andrew Langstaff Johnston, of Richmond, Va. Application filed Feb. 27, 1890. In combination with a suitable support, a pair of spring-actuated arms having their free ends connected to and held apart by the main line wire, electrical conductors upon said arms and arranged to form a loop in the main line, a pair of connectors upon said arms, an arm adapted to disconnect said connectors when the line wire is broken, and a bridge extending across the lower free ends of said arms, whereby a trolley is permitted to pass.

435,102. Fuse-Block; Nathan S. Possons, of Cleveland, Ohio. Application filed June 3, 1890. An elongated cut-out or safety apparatus comprising a base provided with a raised rectangular central portion, a fusible conductor, an insulating support of less width than said raised portion of the base and of greater width than the said conductor, which is secured on the under side thereof, jacks with separate parts on the base and fusible conductor, respectively, the parts on the base being within the area of the aforesaid raised portion, a cover which fits over the fusible conductor, its supports and jacks, and makes a close joint around the said raised portion of the base, and spring catches secured to the base and engaging said cover.

435,105. System for Electric Circuits; Frederick Stitzel, of Louisville, Ky. Application filed May 3, 1890. The combination, with the tracks of a railroad block of a closed electrical circuit including said tracks and a relay at each end of said block, a main normally closed circuit through both semaphores and a battery, a normally open cautionary circuit through each semaphore, and circuit shifters for automatically shifting said battery out of the main circuit into a cautionary circuit.

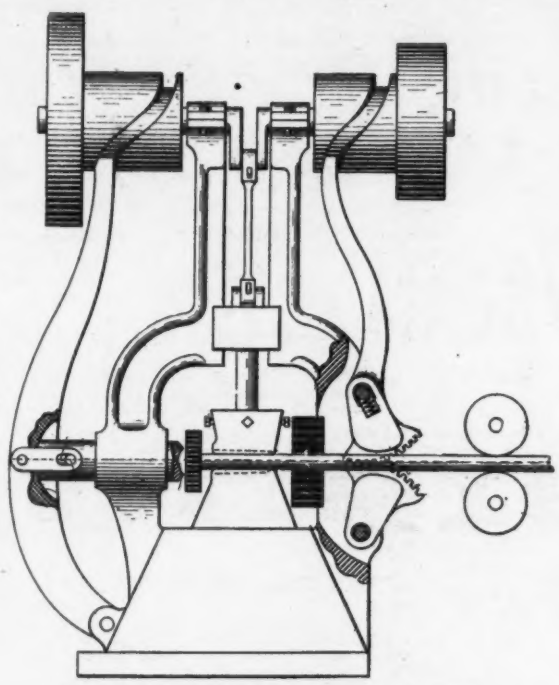
435,110 Electric Forging Machine; George D. Burton, of Boston, Mass. Application filed June 7, 1890. The combination of forging dies, a feeder for feeding the rod to be worked to said dies, and electrodes consisting of bars of conductive material disposed on opposite sides of said dies, one of said bars being provided with an eye through which said rod passes.

435,111. Electric Bar Heating and Feeding Apparatus for Forging Machines; George D. Burton, of Boston, Mass. Application filed June 9, 1890. In a bar heating and feeding apparatus, the combination of movable electro-conductive feed-jaws provided with automatic circuit-closers, and electric conductors in connection therewith.

435,114. Means for Distributing Electrical Energy; Sebastian Z. De Ferranti, of London, England. Application filed April 14, 1887. Patented in England Dec. 9, 1885 and Dec 11, 1885; in France, Dec. 9, 1886; in Belgium Jan. 8, 1887, and in Italy, March 31, 1887. An electrical converter, consisting of a core composed of strips, ribbons, or layers of iron formed closed magnetic circuits, and primary and secondary coils, one superposed upon the other, and each wound in sections or convolution, the adjacent sections, convolutions, or portions of each coil being separated by air-spaces, and air-spaces being left between the inner coil and the core and the outer coil and the core.

435,116. Guard for Electric Light Globes; Robert Martin Gardiner, of Hamilton, Assignor of one-half to William Hilborn, of Ayr, Canada. Application filed Feb. 13, 1889. The combination with an electric lamp and globe, of a guard, placed inside the globe and provided with openings to fit the lamp, and a rim on the outer edge and around the openings.

435,132. Electric Switch; Joseph W. Battershall, of Attleborough, Mass. Application filed July 1, 1890. In an electric switch, the combination, with a rotary wiper and a base provided with a raised circular rim, of metal contact plates secured to the base and projecting therefrom, each plate consisting in a flange fitting the circular projection of the base and wider at one end than at the other, a contact plate projecting from the flange



No. 435,110.—ELECTRIC FORGING MACHINE.

tangentially to the circular rim of the base, and the segmental outer edge of the flange constructed to inclose the rotary wiper and form the resisting contact with the wiper.

435,152. Electric Switch; John Amidon Norton, of Bridgeport, Assignor to John C. English, of New Haven, Conn. Application filed December 28, 1889. In an electric switch, the combination, with the base and the terminals, of a rotative circuit closer, an independently rotative spindle, a spiral spring coiled about the spindle and connected thereto as to one end and as to the other end with a locking and releasing device secured to the circuit closer, and means carried by the spindle and adapted to lift the movable locking device and thereby release the circuit closer.

435,176. Trolley or Contact-Support for Electric Cars; Leonard Atwood, of Philadelphia, Pa. Application filed June 9, 1890. A contact-supporting arm made from coiled wire extending from the car to the contact.

435,223. Electric Cut Out; Charles Heisler, of St. Louis, Mo., Assignor to the United Gas Improvement Co., of Philadelphia, Pa. Application filed April 26, 1889. In a cut-out device, a movable contact and a non-fusible expansible operating piece permanently in shunt to conduct the current and effect the closing of the circuit when the lamp or branch circuit fails to work.

435,248. Electric Arc Lamp; Ernesto Rothlisberger, of Lima, O., Assignor of forty-nine one-hundredths to John W. Wegman and George W. Buchanan, of same place. Application filed March 28, 1890. In an arc lamp a sleeve surrounding the rack-feed, the levers secured to the upper part of said sleeve, and a lever pivoted at one end to a bracket of the supporting plate of the lamp, and having its other end passing through a perforation in the end of a soft iron rod carried by the operating magnet, part of said lever being formed into a loop surrounding the sleeve, and adapted when raised to cause the levers attached to the upper end of the sleeve to grip the rack-feed.

435,259. Electric Device for Preventing Accidents on Railways; Gilmore Thew, of Peru, N. Y. Application filed Feb. 5, 1890. The invention consists of electric conductors placed on or near the track, and conductors on the locomotive carrying contact points designed to come in contact with the line conductors. A rheostat being set to maintain a desired degree of energy on line conductors and a pole changer in the train controlling mechanism to stop the train.

435,261. Generator for Electric Engine Circuits; Charles J. Van Depoele, of Lynn, Mass. Application filed Aug. 10, 1890. The combination, with a sectional commutator and a source of current of stationary commutator brushes on the line of commutation, a movable brush or brushes, and means for imparting to the moving brush or brushes a spasmodic movement toward and away from the stationary brushes.

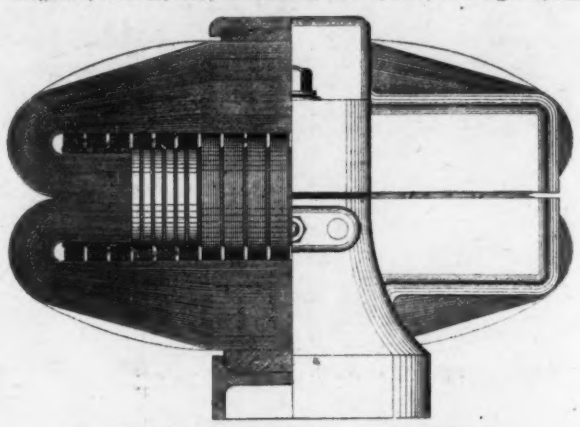
435,263. Electric Railway Conduit with Tubular Conductor; Chas. J. Van Depoele, of Lynn, Mass. Application filed May 22, 1890. A tubular conductor and fixed contact devices extending from the exterior to the interior thereof.

435,283. Method of and Apparatus for Welding by Electricity; Charles L. Coffin, of Detroit, Mich. Application filed Dec. 2, 1889. The invention consists is bringing the edges or ends of two articles which are to be welded in contact, or nearly so, clasping the edges to be welded between conductors, connecting one of the articles to be welded with one pole of a generator of electricity, connecting the clasp which embraces the edges to be welded with the other pole of a generator, and passing a heating current through the circuit thus formed.

435,262. Structure for Supporting and Insulating Suspended Bare Conductors; Charles D. Van Depoele, of Lynn, Mass. Application filed April 18, 1890. A conductor support comprising double transverse rods or wires, a connection of insulating material attached to and uniting said rods and a conductor sustained by the insulating connection.

435,284. Process of Heating Metals by Electricity; Charles L. Coffin, of Detroit, Mich. Application filed April 8, 1890. The process of heating metals electrically, consisting in connecting the article to be heated with one pole of a generator, bringing the part to be heated in contact with a conductor connected with the other pole of a generator, passing a heating current through said article and said conductor, and localizing the heating effect of the current by a magnet.

435,292. Autographic Telegraph; Harry Etheridge, of Pittsburgh, Pa. Assignor to the Writing Telegraph Company, of New York, N. Y. Application filed Nov. 14, 1887. Patented in England, Nov. 29, 1887; in Austria, Jan. 5, 1888; in Belgium, Jan.



No. 435,114.—DISTRIBUTION OF ELECTRICITY.

31, 1888; in Victoria, Feb. 9, 1888; in New South Wales, Feb. 13, 1888; in South Australia, Feb. 15, 1888; in New Zealand, Feb. 20, 1888; in France March 20, 1888; in Queensland, March 21, 1888; in Spain, April 30, 1888; in India, June 12, 1888; and in Italy, Aug. 21, 1888. The combination with the receiver and transmitter of an autographic telegraph, and a switch comprising a switch lever and three separate contacts for receiver, transmitter, and ground, respectively, of a central office with a station of an autographic telegraph exchange system.

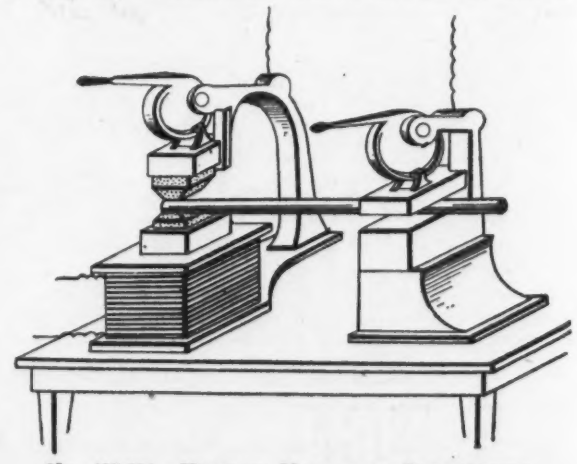
435,295. Automatic Telephone Connector; William Hutson Ford, of St. Louis, Mo., Assignor, by direct and mesne assignments to the Automatic Electric Exchange Company, of East St. Louis, Mo. Application filed Dec. 31, 1889. In a system of electrical intercommunication, the combination of connecting boxes, counters, a polarized device controlling the returning mechanism of the connecting box, and circuit-connections, whereby when circuit has once been established between the sender and receiver, a subsequent break in that circuit followed by a re-establishment of the same shall have the effect of throwing thereon a current the reverse of that which was upon said circuit before it was broken and re-established.

435,296. Contact Brush for Dynamo; Eugene Franklin, of Greenville, S. C. Application filed Dec. 19, 1889. The combination, with the brush support of an electric dynamo, of a projecting arm clamped on the brush clamp, a clamp on the brush across the fingers thereof, and adjusting screws connecting the ends of the projecting arm and finger clamp.

435,332. Automatic Current Regulator; Rene Thury, of Geneva, Switzerland, Assignor to Cuenod, Sautter & Co., of same place. Application filed Jan. 30, 1889. Patented in France, March 21, 1888; in Belgium, June 30, 1888; in Spain, Oct. 2, 1888, and in England, Oct. 16, 1888. My invention consists in the application of a rheostat controlled by a solenoid or equivalent apparatus by the aid of an external force from any source in such a manner that the position of the movable contact of the rheostat may be intimately dependent on that of the core of the solenoid; that is to say, that for any given position of the core there is a corresponding determinate position of the movable contact, as if the two were mechanically connected. The core of the solenoid is left entirely free in its movements, and operates only to direct a current into a relay or to an electric motor.

435,340. Automatic Electric Train Signal and Controlling Device; William H. Wilson, of New York, N. Y., assignor of one-half to William J. Kelly, of Boston, and Charles H. Arnold, of Woburn, Mass. Application filed July 27, 1889. In a train signal and controlling device, the combination of a vertical signal shaft having a spring controlled lever movable in a horizontal plane, an electro-magnet having an amature and arranged in an open circuit including a battery and a circuit closer, a lever operated by the train for moving the circuit closer to close the circuit, a motor having at one side a horizontally swinging trip lever, and a releasing bar to the motor, and means for connecting the trip lever with the releasing bar.

435,344. Articulated Electro-Magnet; Fred. H. Brown, of Chicago, Ill., Application filed Aug. 5, 1890. The invention con-



No. 435,284.—HEATING METALS BY ELECTRICITY.

sists in an electro-magnet having its core made of permanently magnetized steel sections or links pivoted together in series at their ends, the terminal ends of the series being each provided with a helix of wire, through which electric currents may be passed to vary the magnetic tension.

435,347. Galvanic Battery; Charles J. Hubbell, of New York, N. Y. Application filed Aug. 1, 1890. A porous cup having the carbon element baked in place therein.

435,368. Extension Electrolier; James T. Robb, of Mount Vernon, Assignor to the Edison General Electric Company, of New York, N. Y. Application filed Sept. 21, 1889. The invention consists in employing flexible conductors thrown into a fold between a fixed and movable part of the fixture, with a tension device applied at the fold to preserve the conductors taut.

435,376. Electro-Magnetic Therapeutic Chair; Frederick H. Brown, of Chicago, Ill. Application filed May 29, 1890. An electric and magnetic therapeutic chair having independent conductors, in combination with a battery for generating a primary electric current and a coil for inducing a secondary electric current, electro-magnetic devices having the coils and cores adapted to be independently connected to the conductors, and switches to complete either the primary or secondary current at will.

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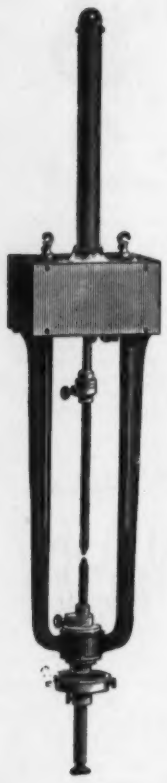

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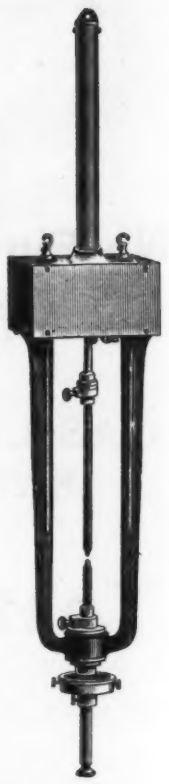

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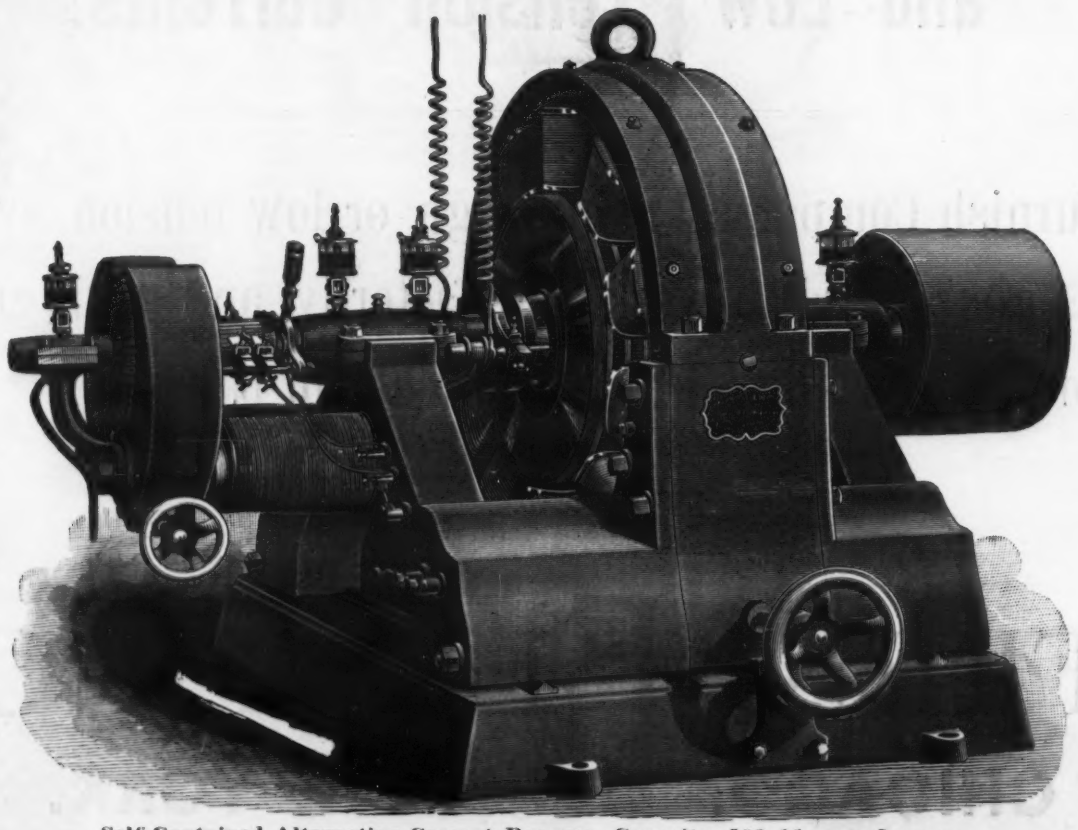

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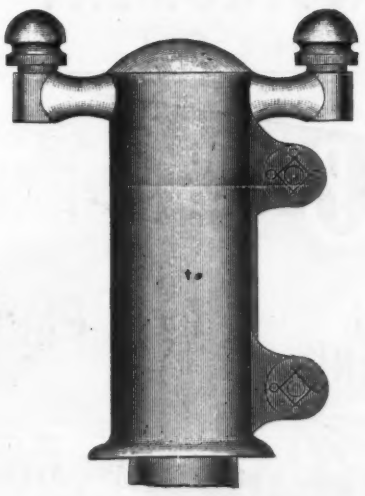

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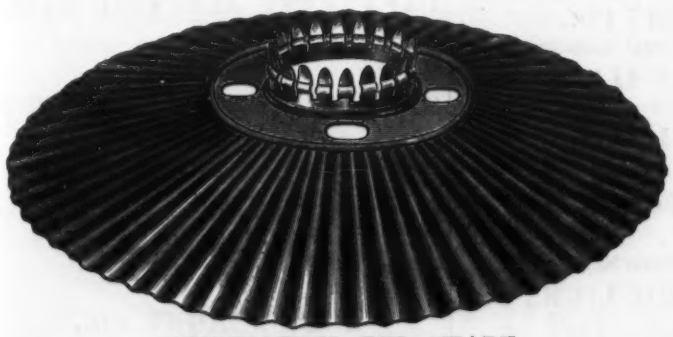

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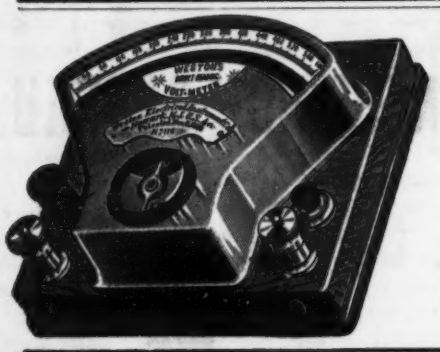

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